Studies in Programmed Learning

Edited by : Gunvant Shah

Centre of Advanced Study in Education
BARODA

CHAROTAR EDUCATION SOCIETY
ANAND

Price : Rs. 25-00

9408.

STATE INSTITUTE OF EDUCATION
Govt. of West Bengal.

Motibhai Amin Centenary Publication Trust Series I

STUDIES IN PROGRAMMED LEARNING

The studies incorporated in this book have all been planned and conducted at the Centre of Advanced Study in Education M. S. University of Baroda, Baroda.

—M. B. BUCH

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GUNVANT SHAH
Editor

Planned by

THE CENTRE OF ADVANCED STUDY IN EDUCATION
THE M. S. UNIVERSITY OF BARODA
BARODA

Published by

CHAROTAR EDUCATION SOCIETY.
ANAND (W. R.) GUJARAT STATE
INDIA

Library
25/3, B. C.

July 1974
Ashadh 1895

[illegible] LIBRARY
Date 24.10.05
Accn. No. 12008

First Edition 1974

9408

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Published by Shri I. J. Patel, Chairman, Charotar Education Society, Anand and printed at Sahitya Mudranalaya, Ahmedabad.

STATE INSTITUTE OF EDUCATION
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FOREWORD

Unreflective salesmanship, uncritical consensus and loud cheering are some of the factors which go against an innovation in the long run. In order to avoid such a mishap, an innovation should be given a fair chance to demonstrate its merits in actual operation. If this is not done, acceptance or rejection of an innovation can prove detrimental. Research workers at the Centre of Advanced Study in Education rightly felt that programmed learning held the promise of being useful to teachers and hence deserved an honest trial in the Indian situation. The Centre had decided to concentrate on some selected areas of research so that something substantial could be contributed in the area. Programmed learning was one such area selected for intensive exploration.

The strategy of the Centre has been to make intensive studies in selected areas at the doctoral as well as at the master's level. The book contains reports of investigations taken up by the editor and other research workers.

This happens to be the first publication on research in programmed learning in India. It is likely to open up new vistas for many researchers who wish to probe further. I am sure that the book would provide exceedingly useful material for researchers in the field.

I welcome the publication as it makes a very substantial beginning of systematic efforts to explore the field of programmed learning in the country. I congratulate the research team of the CASE for the job well done.

Gujarat University,
AHMEDABAD-9.

I. J. Patel
Vice-Chancellor

PREFACE

It is expedient that developing countries should address themselves to the task of acculturation of educational technology. Certain local requirements of the developing countries should be no barrier to the adaptation of proven strategies of learning the programmed way. The combined criteria of instructional output and economic viability should make it possible. It is here that indigenous research in programmed learning can play a very vital role. It should be noted that programmed learning does not provide a miracle cure for the crises in education. It, however, does make an attempt at rationalisation that goes beyond the categories and dreams that we cherish today.

The Centre of Advanced Study in Education, Baroda took upon itself some major and minor investigations in the field. The papers included in this book cover certain aspects of programmed learning. They are :

(1) comparative studies with regard to the relative effectiveness of programmed learning material;

(2) experimental studies with regard to various forms and response modes; and

(3) correlational studies in relation to certain personality dimensions.

The book also contains a chapter on conspectus of research work done in other countries. The chapter further deals with certain down-to-earth problems of experimental design, educational administration and personal problems of a researcher in taking up a study in programmed learning in India either at the individual level or at the institutional level.

Our society is now changing so rapidly and continuously that institutions developed in a relatively stable society are continually mismatched with the functions they ostensibly exist to perform. A school is one such social institution which needs to be reconstituted in a form which makes it respond to changes in the social environment in which it operates. One of the safest ways of resisting change is to adopt what Schon describes as 'dynamic conservatism'. This implies formal acceptance of an innovation without serious intentions to implement the same. Programmed learning is an innovation which will have to meet with several forces against change. One of the strategies of meeting such forces is to convince the consumers by proving the utility of the new idea or the product. Let the product speak for itself just as penicillin did once.

I take, here, the opportunity to thank all the contributors for their painstaking efforts in completing the projects either at doctoral or at master's level. I left the Centre to join the Technical Teachers' Training Institute at Madras in April 1972. My colleagues at CASE have spared nothing to make this volume what it is now. I thank them all.

Dr. Buch was a force behind whatever we did at the Centre. This volume would not have been in its present shape but for his help. I acknowledge this with humility and a sense of indebtedness.

We feel honoured and proud that this publication is the first in the Motibhai Amin Centenary Publication Trust Series sponsored by the Charotar Education Society, Anand, a premier educational institution of Kaira District. We are grateful to the society, particularly its Chairman Shri I. J. Patel and Secretary Shri V. J. Patel for undertaking this publication in the memory of the great educator of the Ex-Baroda State, the late lamented Motibhai Amin.

Gunvant Shah

CONTENTS

Foreword iii

Preface iv

1 Programmed Learning Vis-a-Vis Traditional Teaching: A Study 1

G. B. Shah and V. Krishnamurthy

2 The Use of Linear and Branching Programmes under Supervised and Non-supervised Situations 9

Mohammed Hussain

3 Effectiveness of Four Response Modes in Programmed Learning—An Exploration 28

G. B. Shah

4 Different Forms of Programmed Learning Material—A Comparative Study 44

V. Krishnamurthy

5 Relationship Between Personality Variables and Achievement of Pupils on Programmed Learning Material 82

G. G. Kapadia

6 Relationship Between Anxiety, Persistence and the Performance on a 'Programme' 138

P. K. Gangopadhyay

7 Using Programmed Learning for Remedial Teaching in a Rural Area: An Action Research 155

G. B. Shah and G. G. Kapadia

8 A Conspectus of Studies in Programmed Learning 166

G. B. Shah

STUDIES IN PROGRAMMED LEARNING

Programmed Learning Vis - A - Vis Traditional Teaching : A Study

— A study has been undertaken to see whether programmed learning can establish its worth as a classroom practice and facilitate better learning. Thus the study is of comparative nature, having one group of students to learn traditionally and another through a programme on 'Directed Numbers : Addition and Subtraction'. For the study Equivalent Groups Technique was applied and the pupils from a village were matched on the basis of the I. Q. In the city school no matching was done. The groups were compared in terms of the scores on the teacher made test and on the criterion test. The critical ratios obtained do show the programmed materials to be as effective as the traditional method of teaching.

There has been a resurgence of interest in recent years in the investigation of the effectiveness of Programmed Learning materials. Many researchers the world over have tried to compare the effectiveness of programmed material in relation to that of traditional teaching in the class. Feldhusen and his collaborators (1962) for example, could not find any significant difference between the traditional group and the programme group, but use of programmed material reduced the time required for acquiring the skills in arithmetic to fourteen weeks which otherwise required one year. Hughes and Mc Namara (1961) in their study with maintenance trainees found programmed instruction superior to the lecture method on both the post-test and in time needed for completing the unit. Smith (1962) compared programmed instruction and the conventional method using 128 college students. No difference was found on

G. B. SHAH AND V. KRISHNAMURTHY

the post-test scores obtained by the two groups but there was a 30 per cent saving in time with the programmes. Hough (1962) found the teaching machine to be superior to the lecture in terms of time and responses. Ripple's (1963) study also supports the superiority of the programmed method over the traditional lecture method. James Hartley (1966) has compiled the first comprehensive list of the studies comparing programmed instruction and conventional instruction. It appears from his analysis that programmed instruction is superior to traditional methods of teaching.

There are special problems which a teacher in a developing country like India has to face: overcrowded classes, poor economic resources, dearth of trained and qualified teachers – to mention but a few.

The development of programmed learning materials in India for use with school children has given rise to a great deal of research which may have implications for our educational system. Sharma (1965) developed a lesson in geography on the programmed model and compared it with traditional methods of teaching. Obtained results showed a gain of 23.10 points in the programmed group but only 9.12 points in the traditional group. The difference was significant at .01 level. Sharma (1966) developed a programme on Sets for class IX and compared its effectiveness with the lecture method. Although the differences were not significant, the study provided enough evidence to accept the desirability of using such programmes. Desai (1966) studied the relative effectiveness of programmed learning and traditional classroom teaching in a unit of language learning. The difference was significant at .01 level and it was in favour of programmed instruction. Sharma (1968) compared the programmed method of teaching algebra with the traditional method. The mean achievement of the experimental group was 2.5 points higher than the control group which was taught in the traditional way. The obtained mean gain was significant at 1 per cent level. Shah's (1969) study has established the superiority of auto-instructional programmes over the traditional method of teaching. Furthermore, she found that it was possible for the students of standard V to learn the units in algebra of standard VIII through programmed materials. The study conducted by Mathur (1970) also indicates the workability of programmes as tools of instruction. Both high achievers and low achievers benefitted equally by autoinstructional programmes though high achievers gained more than the low achievers. Kulkarni (1968) has prepared programmes on 'Introduction to Algebra' and 'Solving Simple Equations' and his study helps to gain more insights. Mullick (1968) used programmed learning lessons in a correspondence course for B. Ed. students and the results were strongly in favour of the programmed lesson rather than the lesson planned in a traditional way.

THE PROBLEM DEFINED

The present study is concerned with a comparison of the relative effectiveness of the programmed lesson vis-a-vis the traditional method in teaching a unit in Algebra in standard VIII.

For the purposes of the present inquiry the following definitions were accepted:

(1) Programmed Lesson : In this investigation the term 'Programmed Lesson' implies the Skinnerian way of programming which requires a student to construct a response overtly.

(2) Traditional Teaching : By 'Traditional Teaching' the investigator means the method, which is followed by a subject teacher under normal circumstances. This may differ from teacher to teacher but it generally implies lecturing, discussing, note giving, etc.

(3) 'Effectiveness' is measured in terms of the pupils' performance on the two tests given after the experi-

ment is over, (i) Criterion test and (ii) Teacher-made test.

CONDUCT OF THE EXPERIMENT

For the present inquiry, it was decided to restrict the experiment to one village school and one city school.

In the village school, Equivalent Groups Technique was applied and the individual pupils were matched on the basis of the intelligence quotient, sex and age. Intelligence was measured by Shah's Non-Verbal Group Test of Intelligence.

In the city school no matching was done. The two divisions of standard VIII were kept as they were and the achievements were compared. The experiment was restricted to two divisions of pupils in both the schools. The performance of the students was considered in terms of the scores obtained by them on the teacher - made test and on a criterion test given in the programme itself. The teacher-made test was used in order to guard against the possible advantages of the programme group. The two independent variables were programmed material and the traditional method of teaching. The programme on 'Directed Numbers' prepared by Dr. G. B. Shah, Reader, Centre of Advanced Study in Education, Baroda was of linear construct type having 95 frames in which the correct responses were given on the left hand side of the same frame facilitating immediate knowledge of results. The programme contained the criterion test which was administered after completing the programme. Care was taken to see that the teacher with the traditional group did not go through the programme. It was thought that his association with the programmed material would tempt him to use both the technique and illustrations used in the programme. It should be noted that equal time was given to both the methods.

ANALYSIS AND INTERPRETATION OF DATA

Following are two tables showing the comparisons of relative achievements of the programme group and the traditional group in rural as well as urban areas. The comparisons have been on the basis of the criterion test and the teacher-made test.

Table 1 : Comparison of the Relative Achievements of Programme Group and Traditional Group in the Rural Area

Test given	Group	Mean	SD	N	CR	Significance
Teacher-made test	(i) Programme group	7.22	1.6	45	0.125	Not significant
	(ii) Traditional group	7.18	1.46	45		
Criterion test	(i) Programme group	5.24	1.71	45	0.26	Not significant
	(ii) Traditional group	5.15	1.56	45		

From the table it can be seen that :

(i) the difference between the mean scores of the two groups on the teacher–made test is not significant either at .01 level or at .05 level although the performance of the programme group is slightly better.

(ii) the difference between the mean scores of the two groups on the criterion test is not significant either at .01 level or .05 level although the performance of the programme group is slightly better.

(iii) the null hypothesis is retained.

Table 2 : Comparison of the Relative Performance of Programme Group and Traditional Group in the Urban Area

Test given	Group	Mean	SD	N	CR	Significance
Teacher-made test	(i) Programme group	7.88	1.26	43	1.73	Not significant
	(ii) Traditional group	8.33	1.2	48		
Criterion test	(i) Programme group	5.0	2.16	43	0.436	Not significant
	(ii) Traditional group	5.19	2.0	48		

From the table it can be seen that :

(i) the difference between the mean scores of the two groups on the teacher-made test is not significant either at .01 level or at .05 level although the performance of the traditional group is slightly better.

(ii) the difference between the mean scores of the two groups on the criterion test is not significant either at .01 level or at .05 level although the performance of the traditional group is slightly better.

(iii) the null hypothesis is retained.

Resume

The present investigation was undertaken in order to compare the relative effectiveness of the programmed lesson and the traditional method for teaching addition and subtraction of directed numbers. Schools from both rural and urban areas were selected for the present study.

From the results of the two pairs of critical ratios obtained for the performance on criterion test and teacher-made test of the group it can be inferred that the use of programmed materials does not hinder the performance of the student in any way and it is at least as effective as the traditional method of teaching. Of course, a teacher with programmes at his reach has the added advantage of attending to the individual needs of both the underachievers and gifted children. The results of these comparisons point to the worth of programmed materials.

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2

The Use of Linear and Branching Programmes Under Supervised and Non–Supervised Situations

—The author reports a study undertaken to compare experimentally the efficacies of linear and branching programmes under supervised and non-supervised situations. A Sample of 184 pupils of Standard IX, consisting of 92 pupils from rural schools and 92 from urban schools was taken for the study and a programme on 'Factors Affecting Air Pressure' written in linear and branching forms was used. The programme was given both under supervised and non-supervised situations.

Using the analysis of covariance, no significant difference was found between the two supervised situations, but linear supervised was less effective than linear non–supervised. Similarly there was no significant difference between the supervised and non–supervised situations using a branching programme. A comparison of the rural and urban groups suggests that supervision is necessary with linear forms.

Programmed Learning material can be given to the learner under two situations, namely supervised and non–supervised. The supervised situation, requires the teacher to be present throughout the learning process, performing a number of functions in the classroom such as distributing the programmes, giving instructions and illustrations, supervising the classroom, maintaining the discipline, intermittently checking the answer sheets of the students, helping the students whenever necessary and administering the criterion test in the end. This supervised situation helps in internally motivating the learners, putting a check on manipulation and cheating activities, and giving a sense

MOHAMMED HUSSAIN

of security to them. Inspite of these advantages, the supervised situation has certain limitations. For example, the radically different rate of completion of the programme creates some administrative difficulties in the classroom, the individuals work under group pressures and " the slow learner may be tempted to take unnatural speed in reading, he may hurry up and try to maintain the pace of the faster students." (Gotkin, 1964). Much interference by teacher may hamper the auto-instructional characteristic of PLM.

The non-supervised situation means absolute or partial absence of the human teacher during the learning process of the programme. This situation can be created by the withdrawal of the teacher from the classroom, by asking the students to sit wherever they like, and by giving the programmes to the students for home-study. This situation has the advantages of providing a free atmosphere to the students, providing him adequate time to think and concentrate more deeply and independently, freeing him from group pressures, saving valuable class time and providing opportunities to develop self-study habits.

If programmed learning material can work under the non-supervised situation without sacrificing the quality of learning, it has far better prospects. Many educationists prefer the use of PLM for remedial instruction and for enrichment of instruction, rather than just using it for regular instruction. At school or college level PLM can be used for enrichment, remediation, and review of regular instruction which call for a non-supervised situation. PLM can also be used for continuation education, adult education and correspondence education if it can work well even without the supervision of a human teacher.

The question whether PLM can be used effectively under a non-supervised situation has been answered by various researchers. A study done at Huntington, Long Island, with a spelling programme concluded that the students working at home made gains equivalent to those who worked in school under supervision (Gotkin, 1964). Similar experiment was done at Hillside, New Jersey, and it was found that there is no significant difference in the achievement of the two groups. In this study the students showed a liking to work at home saying that "they get more time to think and they are not unnecessarily hurried" (Gotkin, 1964).

Basu and others (1968) compared the conventional lessons with programmed lessons in a correspondence course (non-supervised situation) and concluded that "this study tends to indicate that programmed instruction when given through correspondence could be at least as effective as when it is given in normal classroom situation". However the authors have mentioned that it is particularly so when the students are motivated and fairly mature. Jacob and others (1966) found that classes taught by a programme alone, learned significantly less than when taught by either a teacher alone, or a combination of the two.

Bertz, Wayne and others (1965) found that PLM is more effective when teachers supervised a college student's completion of the programme than when there was no teacher supervision. But Frank Ryan (1969) did not find any significant difference between the two groups when the programme was given under the supervised and non-supervised situations. In India, Mullick (1968) gave a programmed correspondence lesson to one group of B. Ed. and a conventional lesson to another group of B.Ed. correspondence course and found that the experimental group achieved significantly better.

Although, there is not much evidence on the issue it is assumed that two types of environments - rural and urban - give rise to different characteristics among the study habits of the students. The needs of rural students are different from those of urban students, and the former gets a comparatively inferior type of academic environment, inside and outside the school. But unfortunately, most of the innovations are experimented and tried in urban schools only and do not reach the rural schools. This state of affairs is unhealthy for India because a great majority of the student population of India resides in rural areas. The researches so far done in other countries have not touched the variables of rural and urban settings. No study has so far been done in India in which this variable was studied except in one case for which the data were collected from a rural area (Shah and Kapadia, 1970).

Keeping in view the three treatment variations viz. style variations, situation variations and environmental variations, an experiment was conducted to find out the comparative effectiveness of the programmed learning material.

PURPOSE OF THE STUDY

The objectives of the experiment were as follows :

(1) To develop the programmed learning material on one unit of geography in two different styles, namely, linear and branching.

(2) To compare the relative effectiveness of :
  (a) linear and branching programmes.
  (b) linear programmes under supervised and non-supervised situations.
  (c) branching programmes under supervised and non-supervised situations.
  (d) linear supervised and branching supervised situations.
  (e) linear non-supervised and branching non-supervised situations.

For the present investigation, the term 'relative effectiveness', refers to only one criterion, that is, the level of performance of these treatment groups measured by the criterion test given immediately after the completion of the programme.

CONDUCT OF THE EXPERIMENT

Sample

The subjects of the experiment were 194 pupils - boys and girls - of standard IX, studying in five schools, out of which three were rural schools and two were urban schools of Baroda city. The students were randomly assigned to four treatment groups. The age of the subjects ranged from 14 to 18 years.

Material

The following material was used for the conduct of the experiment :

(i) Linear programme
(ii) Branching programme
(iii) Criterion test
(iv) Intelligence test

(i) Linear Programme

A programme on 'Factors Affecting Air Pressure' was prepared by the investigator himself, in linear style. The development of the material was done according to the specifications of developmental procedure. The programme consists of 81 linear frames and two types of response mechanism - viz. blanks to be filled in and alternatives out of which one was to be selected, were used. The correct responses were given on the left hand margin of the frames and were required to be masked with a slider.

(ii) Branching Programme

The second tool for investigation was a branching programme, written on the same content. This was also prepared by the investigator according to the developmental procedure advocated by the programmers. There were 22 prime path frames and 21 remedial frames, two frames being printed on one page. The frames fulfilled all the requirements of standard branching frames. The order of frames and pages were scrambled according to the specifications of the branching text-book.

(iii) Criterion Test

To measure the performance of the students after reading the programmes given under different situations, a common criterion was needed for both the programmes. The criterion test was also prepared by the investigator. The criterion test consists of 15 questions, and in all 37 objective type items out of which 16 were of the recall type, 7 were of the recognition type and 14 were of the matching type.

(iv) Intelligence Test

In order to measure the intelligence of the students, which was assumed to be an intervening variable affecting the criterion performance of the students, the Desai-Bhatt Group Intelligence Test was used. It is a verbal test in Gujarati, standardized on a large population of Gujarat.

Experimental Treatments

The comparative nature of the experiment necessitated the four treatment groups which are as follows:-

(i) Linear supervised group
(ii) Linear non-supervised group
(iii) Branching supervised group
(iv) Branching non-supervised group

A brief description of these treatments is given below:

(i) & (iii) Linear and Branching Supervised

The linear and branching programmes were given to the two groups of the students in the same classroom. The investigator distributed the programmes and gave the instructions as to how to use them. Then the students read the programmes. The investigator was present all the time in the classroom for maintaining discipline, intermittently checking the answersheets of the students in order to ensure that students were not involved in manipulative activities, specially in the case of linear programmes, and clarifying the doubts whenever necessary.

(ii) & (iv) Linear and Branching Non-supervised

The linear and branching programmes were given to the two groups of students and given the instructions they were asked to go to the next room or library, and complete the programme. They were instructed to bring the programmes and answersheets as soon as they finished reading. The investigator was not present while the students went through the programmes.

Procedure

The experiment was conducted in two phases, separately, in the urban and rural schools of Baroda District.

First Phase : Uraban Schools

The experiment was conducted in two schools of Baroda city in the manner stated below:

The experimenter first administered the intelligence test. Then the entering behaviour test was given to all the students. After this, the students were randomly assigned to four groups. Two groups were given branching programmes and two groups were given linear programmes. The instructions were given to them regarding the use of the programme.

Then the groups – one linear and one branching group – which were to be given the non-supervised treatment were given additional instructions regarding the procedure of reading the programme. They were asked to go to the next room, read the programme, and come back with the programme and answersheets as soon as they completed reading.

The other two groups – one linear and one branching – were asked to read the programme in the class itself undər the supervision of the investigator. The investigator, besides helping these students who sought his assistance, tried to put a check on the undesirable activities of the students such as cheating or manipulating the programme.

When all the students completed the programme, the criterion test was administered on all the students at the same time.

Second Phase : Rural Schools

The second phase of the experiment was conducted in three rural schools of Baroda District. The same procedure was ollowed in these schools also.

ANALYSIS AND INTERPRETATION

In order to get a general picture, the scores were first analysed in terms of frequency distribution and percentages, important from the programming point of view. The number of students getting various percentages of marks are shown in the tables below for rural and urban samples, separately.

Table 1 : Number of Students Getting Various Percentages of marks on the Criterion Test (Rural Schools)

Percentage of marks	Linear supervised		Linear non-supervised		Branching supervised		Branching non-supervised	
	No.	%	No.	%	No.	%	No.	%
Above 70	17	74	12	52	17	74	17	74
Above 60	20	86	19	83	23	100	21	92
Below 60	3	13	4	17	–	–	2	8

Table 2 : Number of Students Getting Various Percentages of Marks on the Criterion Test (Urban Schools)

Percentage of marks	Linear supervised		Linear non-supervised		Branching supervised		Branching non-supervised	
	No.	%	No.	%	No.	%	No.	%
Above 70	12	52	4	17	10	43	6	26
Above 60	18	79	13	57	16	70	23	100
Below 60	5	21	10	43	7	30	—	—

It can be observed from the above tables that in general, all the programme treatments were able to gain minimum scores of 60 per cent, with a slight variation among the treatment groups of both the samples—rural and urban. The programme treatments worked with equal effectiveness in rural schools also. It can be observed from the percentages of the scores that the linear supervised treatment was superior to all the other treatments and that the linear non-supervised treatment ranks the lowest in order.

Analysis of Covariance

For a better and sophisticated analysis of the available data, the analysis of covariance was used. The comparison between the means of criterion scores of all the treatments was the criterion to judge the relative effectiveness of the treatment groups. For a reliable interpretation we need to have matched the groups on the entering behaviour. But the groups were not matched in the present study. So the analysis of covariance was used because "through it (covariance) one (experimenter) is able to make adjustments in the terminal scores which will allow for difference in some initial variable" (in this case, intelligence Garrett, 1969). The analysis of covariance is able to test the null hypothesis and to give a quantitative picture by making it possible to see at which level (.01 or .05) the difference exists.

The summary of the computation of analysis of covariance for rural and urban samples is given separately in the tables that follow.

Table 3 : Analysis of Covariance of Criterion Scores of Rural Sample

Source of Variation	df	SSx	SSy	Sxy	SSyx	MSyx	SDyx
Among Means	3	839.74	167.87	265.65	116.29	38.76	
Within Groups	87	7887.92	1412.44	864.09	1317.79	15.14	3.89
Total	90	8727.66	1580.31	1129.74	1434.08		

After the computation of correlation and regression of the data, the significance of difference of adjusted Y means was calculated as below :

$$\text{SD yx} = \sqrt{15.14} = 3.89$$

$$\text{SEMyx} = \frac{3.89}{\sqrt{23}} = \frac{3.89}{4.79} = .81$$

SE_D between any two adjusted means

$$\text{SD}_{\text{yx}} = .81 \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}$$

$$= .439$$

Significance of difference at .05 level = 1.99 × .439
= .87

Significance of difference at .01 level = 2.63 × .439
= 1.15

Table 4 : Analysis of Covariance of Criterion Scores of Urban Sample

Source of Variation	df	SSx	SSy	Sxy	SSyx	MSyx (Vyx)	SD yx
Among Means	3	219.61	112.30	59.28	106.93	35.64	
Within Groups	87	9529.22	1630.87	452.66	1609.35	18.38	4.28
Total	90	9748.83	1743.17	511.94	1716.28		

After the computation of correlation and regression, and adjustment of the Scores, the significance of difference of adjusted Y means was calculated as below :

$$\text{SDyx} = \sqrt{18.38} = 4.28$$

$$\text{SE Myx} = \frac{4.28}{\sqrt{23}} = .89$$

SE_D between any two adjusted means

$$\text{SDyx} = \sqrt{\frac{1}{N1} + \frac{1}{N2}}$$

$$= .483$$

Significance of difference at .05 level = 1.99 × .483
= .961

Significance of difference at .01 level = 2.63 × .483
= 1.24

The comparisons of various treatments and the significance of difference between any two treatment groups is shown in the tables that follow :

Table 5 : Significance of Difference Between the Adjusted Means of any Two Treatments in Rural Sample

Treatment Groups	Adjusted means	Comparisons	Difference	Significance
A. Linear supervised.	27.05	A & B	2.40	Significant at .01 level
B. Linear non-supervised.	24.65	A & C	0.69	Not significant
C. Branching supervised	27.74	A & D	0.16	Not significant
D. Branching non-supervised	26.89	B & C	2.09	Significant at .01 level
		B & D	2.24	Significant at .01 level
		C & D	0.85	Not significant

Table 6 : Significance of Difference Between Adjusted Means of any Two Treatments in Urban Sample

Treatment Groups	Adjusted Means	Comparisons	Difference	Significance
A. Linear supervised	24.71	A & B	2.87	Significant at .01 level
B. Linear non-supervised.	21.84	A & C	0.84	Not significant
C. Branching supervised	23.87	A & D	0.01	Not significant
D. Branching non-supervised	24.70	B & C	2.03	Significant at .01 level
		B & D	2.86	Significant at .01 level
		C & D	0.83	Not significant

On the basis of the analysis of covariance the following observations were made :

(a) The linear supervised was found to be superior to linear non-supervised, in both rural and urban samples.

(b) The branching non-supervised was found to be significantly better than linear non-supervised.

(c) The branching supervised was found to be significantly better than linear non-supervised.

(d) The branching supervised and the branching non-supervised were not found to differ significantly.

(e) The branching supervised and the linear supervised were not found to differ significantly.

(f) The branching supervised and the linear supervised were not found to differ significantly.

OBSERVATIONS

On the basis of the analysis and interpretation of the data the following specific conclusions can be drawn:

(1) Programming Style

As there is no significant difference between the linear supervised and branching supervised treatments in both the samples - rural and urban - it can be concluded that as far as the topic of geography is concerned both linear and branching styles are equally effective. The findings of this experiment confirm the results of studies by Roe and others (1960) and Larkin and Leith (1969), who also could not establish any significant difference between linear and branching styles.

(2) Supervised and Non-Supervised situations

(a) Linear programme under non-supervised situation

There is a significant difference between the linear supervised and linear non-supervised treatments in both the samples; linear supervised treatment is found to be less effective. The findings of this experiment confirm the results of studies of Roe (1962), Bartz Wayne and others (1965) but not of Ryan (1969) and Gotkin (1964). The views of Fry (1963) that the possibilities of manipulation of the programme and cheating are greater in a non-supervised situation, have a definite bearing upon the quality of learning, and seem to be supported by this study.

So, it can be concluded that for effective results on a linear programme the supervision by the human teacher is desirable.

(b) Branching programme under non-supervised situation

In the case of a branching programme it is found that there is no significant difference between supervised and non-supervised treatments in both the samples. Therefore it can be concluded that branching programmes are equally effective

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in both supervised and non-supervised situations. The absence of a human teacher does not affect the level of performance. This finding supports the claim put forth by the Crowderians that branching programmes have internal control over cheating.

Within the limits of this experiment it can be concluded that if a programme is to be given under a non-supervised situation, the branching programme is a better choice compared to the linear programme.

(3) Rural and Urban Settings

Though the collection and analysis of the data of rural and urban samples were done separately, it was not considered desirable to compare these data statistically, because of the small size of the sample. However, the overall comparisons of the adjusted means of the four treatment groups of urban and rural samples are shown in the table below:

Table 7 : Comparison of the Adjusted Means of Rural and Urban Samples—Treatmentwise

Treatment	Adjusted means		Difference
	Rural	Urban	
Linear supervised	27.05	24.71	2.34
Linear non-supervised	24.65	21.84	2.81
Branching supervised	27.74	23.87	3.87
Branching non-supervised	26.89	24.70	2.19

The above table shows that the level of achievement of the students of rural areas is slightly higher than that of the students of urban areas in all the treatment groups. Nothing can be concluded withconfidence regarding this difference, but at least it can be concluded that if programmes are given to the students of rural areas they will work at least as effectively as in urban areas.

If we compare the rank order of different treatment groups, we find a slight difference, though it is not significant statistically as shown in Table 8.

Table 8 : Ranks of the Four Treatments According to the Adjusted Means of the Criterion Tests

Treatment	Rank in Urban sample	Rank in Rural sample
Linear supervised	I	II
Linear non-supervised	IV	IV
Branching supervised	II	I
Branching non-supervised	III	III

In the urban sample, linear supervised treatment stands first whereas in the rural sample the branching supervised treatment is first in rank order. The linear non-supervised treatment is lowest in order in both samples.

Thus, it can be concluded that programmed learning material can be used in rural schools too.

The conclusions of the experiment in brief, are as follows

(1) Supervision is necessary for linear programmes.

(2) In non-supervised situations branching programmes are more effective than linear programmes.

(3) Both linear and branching programmes can be prepared in subjects like geography.

(4) The programmed learning material can be used both in urban and rural schools.

SUGGESTIONS

(1) For a wider application of programmed learning material specially for the adult learners, programmes of branching styles should be developed for use under non-supervised situations, especially in subjects like geography which involve concepts, generalizations and discriminations.

(2) Since we cannot use teaching machines, it is suggested that when linear programmes are given to the students, the teacher should supervise them.

(3) The programmed learning material should be introduced in rural areas too. Its need is emphasized because the rural schools, suffer from a lack of trained and qualified teachers, and the students of rural areas may not have self-study habits, and are less motivated.

Further researches in this area can be undertaken studying the following aspects :

(1) The relative effectiveness of linear and branching programmes may be studied in terms of speed and power of retention.

(2) The linear and branching programmes may be developed in different subject areas involving skills, facts, information as well as concepts, generalizations etc. Their relative effectiveness may be found out.

(3) Studies may be undertaken to compare the relative effectiveness of linear and branching paogrammes, with reference to other variables like self-study habits of students, their attitude towards the subject, their scholastic achievement in general, as well as in a particular subject, level of motivation and other personality characteristics.

(4) Some more studies might be undertaken in order to study the effectiveness of programmed learning material in other non-supervised situations like correspondence courses, home study etc.

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3

Effectiveness of Four Response Modes in Programmed Learning—An Exploration *

—The author reports a study undertaken to compare experimentally the efficacies of four different modes of responding in programmed learning. A sample of 188 pupils of Standard VIII was taken from two secondary schools in Baroda city and Shah's programme on Addition and subtraction of Directed Numbers was given separately to the pupils of the two schools. The pupils responded either overtly or covertly. Each group was further divided into a group making constructed responses and a group reading the frames with answers already filled in. Significant differences were found on the immediate test scores of the four treatment groups, but not on the retention scores, The covert response prompt group showed an appreciable time-saving.

Skinner has described learning in terms of shaping of behaviour. His behaviourist point of view requires the learner to make an active, overt response. Holland (1960) suggested eight basic rules for programming with reference to the Skinnerian technique. The present inquiry is primarily concerned with the following two of them :

1. Only overt responses suitably reinforced are learned.
2. The students must 'write' the programme.

Both these rules are associated with Skinner's theory of learning. Skinner wishes to eliminate all non-observable factors from the learning situation although he does not

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* This research paper was published in **Indian Educational Review,** January 1971 Vol. 6. No. 1, National Institute of Education, (NCERT), New Delhi.

G. B. SHAH

deny their existence. Skinner further asserts that the student should compose his response rather than select it from a set of alternatives. Classical operant conditioning assumes that the responses must be overt and not covert in order to have 'expressed behaviour' which can be observed, recorded, and used to regulate subsequent behaviour.

As with the other original assumptions, that of the necessity of overt responses is being challenged by research. Experiments have shown that an overt response need not in fact always be made. Campbell (1961) studied the effectiveness of the following four conditions:

1. Subjects write in the response only when sure of its correctness.
2. Subjects write answers in every blank.
3. Subjects do not write answers but mentally compose answers.
4. Subjects read the same frames with no words omitted no blanks to fill.

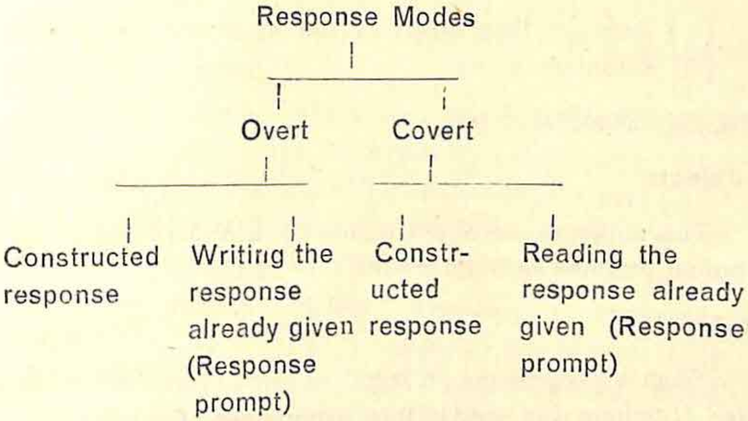
He found that on immediate post-test there was no significant difference among the means of the four groups. Ten weeks later, condition (4) was better than others at 0.05 level. The expectation that condition (1) would make for more learning and same time was not supported. Condition (1) resulted in fewer errors, but these did not show up in learning effect.

Cummings and Goldstein (1962) inquired into the effectiveness of overt vs. covert responding on the learning of verbal and of pictorial material. Significantly higher scores were made by the overt responders on both the verbal and pictorial materials and on both the immediate and the delayed post-tests. The covert responders took an average of 50 minutes to complete the programme; the overt responders about 96 minutes.

Evans (1960) found that students not required to make overt response to items, completed programmes in about 65 per cent of time required by overt responding students. Goldbeek and Campbell (1962) compared overt, covert, and reading (i. e., no blanks to fill in) response modes. He found significant interaction of difficulty with response mode. He found the overt response group performing below others at low difficulty level and above others at intermediate difficulty level. At the most difficult level, the reading mode was highest, but not significantly so. Hughes (1962) compared the covert response mode with the overt response mode while following up '7070 Training' and found that the covert response mode was more efficient than the overt. Koromondy (1960) found no significant differences between the overt and the covert response modes. Lambert and Miller (1962) found that intelligence was significantly associated with the amount of information acquired from the programme. Covert responses proved to require less time than overt ones and to result in about as much learning. Sidowski and Kopstein (1961) found that the covert response proved more efficient than the overt if both the time and amount of learning were taken into account. Silverman and Alter (1960) found that students who simply read items learned significantly more than students who read items and responded actively. Stolurow and Walker (1962) found no significant difference between learning from writing responses and merely thinking them. Covert responses required less time than overt. Leith and Ghuman (1966) found no significant differences between the four treatments selected for the present inquiry. They noted that there was an appreciable Response-mode-Answer interaction the covert constructed response mode being significantly better than the overt constructed response mode, while the two answer groups were not different.

PURPOSE

It was intended to compare experimentally the relative efficacies of the four response modes described below:


Response Modes
Overt
Covert
Constructed response
Writing the response already given (Response prompt)
Constructed response
Reading the response already given (Response prompt)

TERMS DEFINED

For the purposes of the present inquiry the following definitions were used :

1. Overt response : A student's oral, written or manipulative act which is, or can be recorded by an observer.
2. Covert response : An internalized response which the student presumably makes but which is neither recorded nor otherwise available to an observer.
3. Constructed response : A student's effort to complete a sentence, solve a problem or answer a question. A model of the response may be provided for the student to copy, but as long as he writes, says or thinks rather than selecting it from a set of alternatives the response is constructed.
4. Response prompt : A method of responding in which the correct responses are already given in the frame. A student either reads the responses given or copies them out after reading.
5. Effectiveness : The effectiveness of a response mode would be considered in view of the following three criteria :
   - (i) Performance on the criterion test immediately given after the programme.

(ii) Average time taken by the treatment group.

(iii) Retention score.

THE EXPERIMENT

Subjects

The subjects were 188 pupils of Standard VIII in two English medium schools of the city of Baroda.

Materials

Shah's programme on Addition and Subtraction of Directed Numbers was used in this experiment. The programme contains 95 frames written in a linear style. Four versions of the programme were prepared to suit the four treatments described below. The test comprising 10 multiple-choice type and 10 fill-in-the-blanks items was used as a criterion measure,

Experimental Treatments

The treatments consisted of four different response modes of the programme in algebra as mentioned below :

A - Overt-Answer not Given
B - Overt-Answer Given (Response prompt)
C - Covert-Answer not Given
D - Covert-Answer Given (Response prompt)

A description of the treatment is given below :

A - Overt-Answer not Given - The pupils constructed responses and wrote them before ascertaining whether they were correct. They were instructed to write the answers in a separate answer sheet provided. The correct answers were provided on the left hand side of the margin and could be read after removing the paper which covered them.

B - Overt-Answer Given - The pupils wrote the answers which were already given in the blanks. They were instructed to read a frame carefully along with the answer and write the answer given in the blank(s), in a separate answer sheet provided.

C – Covert–Answer not Given – The pupils constructed responses mentally before ascertaining whether they were correct. They were instructed to think of the correct answers and then ascertain whether they were correct by removing the paper on the left–hand side of the margin.

D – Covert–Answer Given – The pupils read the responses which were already given in the blanks. They were instructed to just read the frames carefully along with the correct answers already provided.

Procedure

First Phase

The experiment was conducted separately in the two schools of the city of Baroda. The available samples of 84 subjects in one school and 104 in the other were randomly assigned to the four treatment groups. All subjects were instructed to go according to their own speed and the time taken by each subject was noted in order to set the average time taken by each treatment group. The criterion test was immediately administered after all the members of a group had completed the programme. In all the four groups the oral instructions for the programme as also for the criterion test were given by the same person. The programme was administered in two sessions with a break of 25 minutes.

Second Phase

The criterion test was readministered to the same subjects to measure delayed retention. It was readministered after five days to 84 subjects in one of the two schools and after 15 days to 104 subjects in the other. Retention scores of the four treatment groups were compared. Further, the four groups were also compared in terms of percentage saved.

Third Phase

The effectiveness of a response mode was also judged in terms of the time taken by the four treatment groups. The time taken by an individual pupil was noted down to calculate the average time taken by each group.

Statistical comparisons were made on the following criteria :

1. Scores in the criterion test given immediately after the programme administration.
2. Scores on the delayed retention test given after some days.
3. Average time taken by the four treatment groups in completing the programme.

RESULTS

First Phase

In this phase, differences between the treatment groups on the immediate test scores are discussed.

Table 1 : Mean Scores of Subjects in Four Treatment Groups on Immediate Test Scores in Schools I and II

School		A Overt Answer not Given	B Overt Answer Given	C Covert Answer not Given	D Covert Answer Given
I	$\overline{X}$	14.8	11.6	13.7	15.5
	n	21	21	21	21
II	$\overline{X}$	14.7	12.9	13.8	15.3
	n	26	26	26	26

Table 2 : Analysis of Variance of the Immediate Test Scores for the Four Treatments (School I)

Source of Variation	df	S.S.	M.S.	F	Significance
Among the Means ot Treatments	3	182.8	60.93	7.59	Significant at .01 level
Within Groups	80	641.7	8.02		

Analysis of Variance does not tell us which one treatment is different from the other. In such cases we have to resort to t-test or some other derived techniques. The Least Significant Difference (LSD) Test is one such technique using a pooled error variance (MSW or within-group Variance) technique. The formula for LSD is :

$$LSD = \sqrt{\frac{2MSW}{n}}$$

Where MSW = Within groups variance
n = Number of observations per mean to be compared

$$LSD \text{ at } 5\% = t._{05} \times \sqrt{\frac{2MSW}{n}} = 1.99 \times \sqrt{\frac{2\,(8.02)}{21}} = 1.73$$

$$LSD \text{ at } 1\% = t._{01} \times \sqrt{\frac{2MSW}{n}} = 2.64 \times \sqrt{\frac{2\,(8.02)}{21}} = 2.29$$

Table 3 : Significance of Difference Between Means of any Two Treatments (School I)

Treatments	Difference between Means	Significance
A & B	3.2	Significant at .01 level
A & C	1.1	Not significant
A & D	0.7	Not significant
B & C	2.1	Significant at .05 level
B & D	3.9	Significant at .01 level
C & D	1.8	Significant at .05 level

Table 4 : Analysis of Variance of the Immediate Test Scores for the Four Treatments (School I)

Source of Variation	df	S.S.	M.S.	F	Significance
Among the Means of Treatments	3	88.96	29.65	4.36	Significant at .01 level
Within groups	100	679.93	6.79		

$$\text{LSD at } 5\% = t_{.05} \times \sqrt{\frac{2\text{MSW}}{n}} = 1.98 \times \sqrt{\frac{2\ (6.79)}{26}} = 1.89$$

$$\text{LSD at } 1\% = t_{.01} \times \sqrt{\frac{2\text{MSW}}{n}} = 2.63 \times \sqrt{\frac{2\ (6.79)}{26}} = 1.42$$

Table 5 : Significance of Difference Between Means of Any Two Treatments (School II)

Treatments	Difference Between Means	Significance
A & B	1.9	Significant at .01 level
A & C	0.9	Not significant
A & D	0.6	Not significant
B & C	0.9	Not significant
B & D	2.4	Significant at .01 level
C & D	1.5	Significant at .05 level

Observations (First phase)

1. It can be seen that the overall differences between the treatment means are significant at .01 level in both the schools (Tables 2 and 4).
2. The results on LSD test in both the schools seem to be very consistent with only one exception of treatments B and C.
3. The mean scores of the four treatment groups in both the schools show perfect rank correlation. In both the schools the four treatments could be arranged according to merit in the following order :

First D — Covert-Answer given (Response prompt)
Second A — Overt-Answer not given
Third C — Covert-Answer not given
Fourth B — Overt-Answer given (Response prompt)

Second Phase

In this phase, the differences between treatment groups on retention test scores are discussed. The four treatments are also compared on the retention scores in terms of saving.

Table 6 : Mean Scores of Subjects in Four Treatment Groups on Delayed Retention Test Scores in School I and II

School		A Overt Answer not Given	B Overt Answer Given	C Covert Answer not Given	D Covert Answer Given
I	$\bar{x}$	12.2	12.3	11.6	10.5
	n	21	21	21	21
II	$\bar{x}$	12.1	13.00	12.2	12.7
	n	26	26	26	26

Table 7 : Analysis of Variance of the Retention Test Scores for the Four Treatments (School I)

Source of Variation	df	s. s.	m. s.	F	Significant
Among the Means Treatments	3	41.28	13.76	1.44	Not significant
Within Groups	80	764	9.55		

$$\text{LSD at } 5\% = t._{05} \times \sqrt{\frac{2\text{MSW}}{n}} = 1.99 \times \sqrt{\frac{2\ (9.55)}{21}} = 1.89$$

$$\text{LSD at } 1\% = t._{01} \times \sqrt{\frac{2\text{MSW}}{n}} = 2.64 \times \sqrt{\frac{2\ (9.55)}{21}} = 2.50$$

Table 8 : Significance of Difference Between Mean Retention Scores of any Two Treatments (School I)

Treatment	Difference Between Means	Significance
A & B	0.1	Not significant
A & C	0.6	Not significant
A & D	1.7	Not significant
B & C	0.7	Not significant
B & D	1.8	Not significant
C & D	1.1	Not significant

Table 9 : Analysis of Variance of the Retention Scores for the Four Treatments (School II)

Source of Variation	df	S.S.	M.S.	F	Significant
Among the Means of Treatments	3	18.5	6.16	1.00	Not significant
Within Groups	100	614	6.14		

$$\text{LSD at } 5\% = t.\ .05 \times \sqrt{\frac{2MSW}{n}} = 1.98 \times \sqrt{\frac{2\ (6.14)}{26}} = 1.37$$

$$\text{LSD at } 1\% = t.\ .01 \times \sqrt{\frac{2MSW}{n}} = 2.64 \times \sqrt{\frac{2\ (6.14)}{26}} = 1.81$$

Table 10 : Significance of Difference Between Mean Retention Scores of any Two Treatments (School II)

Treatments	Difference Between Means	Significance
A & B	0.9	Not significant
A & C	1.1	Not significant
A & D	0.6	Not significant
B & C	0.2	Not significant
B & D	0.3	Not significant
C & D	0.5	Not significant

Table 11 : Comparison of Four Treatments on Retention in Terms of Saving (School I)

Treatments	Mean Scores on immediate Test	Mean Scores on Retention Test	Percentage Saved	Rank in Terms of Saving
A	14.8	12.2	82.4	III
B	11.6	12.3	100	I
C	13.7	11.6	84.6	II
D	15.5	10.5	67.7	IV

Table 12 : Comparison of Four Treatments on Retention in Terms of Saving (School II)

Treatments	Mean Scores on Immediate Test	Mean Scores on Retention Test	Percentage Saved	Rank in Terms of Saving
A	14.7	12.1	82.3	IV
B	12.9	13.0	100	I
C	13.8	12.2	88.4	II
D	15.3	12.7	83.0	III

Observations (Second Phase)

1. It can be seen that the overall differences between the treatment means are not significant at any level in both the schools (Tables 7 and 8).

2. The results of LSD test in both the schools seem to be quite consistent as the differences between any two treatments are not significant.

3. In school I, the retention test was given after five days, while in School II after 15 days. In both the schools the four treatments could be arranged according to merit in the following order :

	School I	School II
First	B	C
Second	A	B
Third	C	D
Fourth	D	A

As the differences between the means are not significant it can be said that the four treatments are almost equally effective as far as retention is concerned.

4. As regards the amount saved, it can be seen from Tabler 11 and 12 that treatment B seems to be most effective and treatment C comes next. It should be noted that in both the schools the retention scores with treatment B are little higher than the immediate test scores.

This can be accounted for by possible reminiscence. Treatment D seems to be the least effective in School I but not quite so in School II and less time-consuming than overt.

Third Phase

In this phase, the effectiveness of a treatment was judged in terms of the average time taken by the subjects.

Table 13 : Ranks of the Four Treatments according to the Average Time Taken in Schools I and II

Treatment	Time Taken in Minutes School I	Time Taken in Minutes School II	Ranks School I	Ranks School II
A	94	87	IV	III
B	70	92	III	IV
C	62	76	II	II
D	45	59	I	I

Observations (Third Phase)

1. Treatment D (Covert - answer given) seems to be least time-consuming in both the schools.
2. Treatment C (Covert - answer not given) comes next to D.
3. In any case covert responding appears to be comparatively less time-consuming than overt.

DISCUSSION

The results of the experiment are not in conformity with the two basic rules suggested by Holland. As mentioned earlier, Holland (1960) asserts that only overt responses suitably reinforced are learned and that the students must 'write' the programme. The results have shown that covert responding is at least as effective, if not more, as overt responding from the viewpoint both of immediate and delayed test scores. Furthermore, it is time-saving too. Leith and Guhman (1966) asserted that 'being aware of the answer before making a try does not necessarily lead to poorer learning.' The results of the present experiment support this contention.

It should be noted that treatment D (covert answer given) which required the pupils to just read the frames proved to be most effective both in terms of immediate test scores and the time taken. Skinner's emphasis on overt and active responses does not seem to be tenable after surveying the results of many experiments, including the present one.

The fact that covert responding in the response prompt mode (answers already given in the frames) is quite effective, has many implications in the Indian context. It is often alleged that programmes prove to be costly. Experts advocate the use of the separate answer sheet in order to bring down the cost of a programme. The covert response prompt mode does not even require the answer sheet. It is known that programmes written or printed in the Skinnerian style require many pages because of the big margins provided for correct responses. These margins would become redundant when the students are required to just read the frames with correct responses already filled in. Such a practice would make the programmed learning material somewhat less expensive, both space-wise, and time-wise, without any loss of effectiveness whatsoever.

It seems reasonable that the use of programmed materials holds promise for improving instruction especially in developing countries of Asia. This implies that every effort must be brought to bear upon the problem of making them effective and, at the same time, economical.

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4

Different Forms of Programmed Learning Material : A Comparative Study

— A comparative study has been undertaken in order to test the hypothesis that different programme forms do not differ significantly in their effectiveness. The study with seven treatment forms and a sample of 322 students drawn from eleven classes of std. VIII in the city of Baroda, that is, 46 students randomly selected for each form, reveals that on the immediate post-test (using the Lindquist's analysis of covariance in duplicate experiments in randomly selected schools, thus appropriately controlling the class differences) the Response Prompt Covert Form in which the answers were already filled in the gaps, surpasses others in efficiency at .05 level but on a retention test given after six weeks, the differences are no longer significant. The investigator is of the view that it is necessary to use the index of retention not only in evaluating a form but also in the very preparation of it. The maximum differences are seen in terms of the time taken to finish the programme, wherein the F is significant at .01 level.

Over the past few years many researches have been carried out to try to determine which of the several possible programme forms is the best way of teaching reading, substraction, languages and other fields of instruction. When a form or style makes headway, it is not always because the empirical evidence is in its favour. We have had, rather, a train of studies which are partial and even conflicting. In certain cases, the inferences reached cannot be

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generalized much, but can only be applied to particular lessons or particular sample. In this chapter, an attempt has been made to review the studies made on the subject. As such, this chapter is a critical review of experimental research on variables in programming and programming forms. The criterion for inclusion or evaluation is that the research deals with fundamental variables which apply to all programmes or at least specifically delineated programmes, rather than answering problems specific to a particular case. An attempt has been made to designate findings which are valid and general in their significance for programme forms. It would be impractical to review all researches having implications for programme forms. The review covers only applied research of variables in programming or programme forms, with a mention of certain studies which are important but not immediately related to the problems at hand.

A glance at the available literature reveals that the researches on the techniques of programming, especially those of the early sixties, have largely been the demonstration of the principles laid down by Skinner as guiding principles for preparation of programmes. But the inclusion of later research studies necessitated classification of variables and isolation of pure instances of each variable, and translation of a study into an experimental setting. This has been found to be a difficult task, especially with comparative studies dealing with programmes of different lengths and given under uncomparable learning situations. But the pages to follow, in general, give an orientation into the nature of programme forms and the programme variables and certain outcomes of the research studies.

A careful survey of the existing literature on programmed learning reveals that the articles generally belong to the following two groups : (a) general articles consisting of theoretical discussions or the author's point of view and opinions and (b) experimental studies. The latter group of experimental studies consists of two clusters, one dealing with comparative studies, right from the well-known studies comparing conventional instructional procedures and programmed learning materials through comparisons of linear and branching forms, or other forms like skipping form, hybrid form, etc.; the other cluster deals rather with specific experiments like programme characteristics, that is, role of overt response, role of error-control, role of prompting, and so on. But by and large, the modern trend is not so much to be involved in the debate of 'linear or branching', but rather to have an inter-disciplinary approach wherein the programmer tries to introduce the characteristics belonging to different programme forms.

Inspite of large heaps of studies available in the literature, research has not yet improved upon the principles because the studies have been limited to gross comparisons. The 'vs' in the titles of many investigations suggests the comparison of crude dichotomies without indication of where the two cases fall on the dimension they represent or how this distance could be measured. Consequently, a generalization of results is difficult since magnitudes or differences in important variables cannot be specified for either experimental material or programmes.

Recent years have seen a shift from studies of the 'programmed learning vs. traditional teaching' type towards the actual variables that make or break the efficiency of programmes. In short, to achieve this, different forms of the same programme were prepared but with variations in factors like **response mode** i. e. overt or covert, **nature of response** i. e. constructive vs. multiple choice, **programme forms** i. e. linear vs. branching and so on.

Studies Related to Overt, Covert Response Modes

'Learning by doing' is an age-old dictum which tempts the programmer to demand 'active overt response rather than mere thinking'. But, in this perplexing question of whether the student should write the response rather than merely think it or select one from a multiple choice of answers, the evidence is not clear. The great majority of the studies found no significant differences between the amount of learning from overt (writing) and covert (thinking) responses. As Schramm (1964) puts it, "When a researcher finds a difference, he has statistical tools at hand to calculate the likelihood that his finding is due to chance; when he finds no difference, he has no logically defensible basis". Alter and Silverman (1962), Evans (1960), Evans, Glaser and Homme (1960), Cropper and Lumsdaine (1961 c), Hughes (1961), are all of this n. s. d. nature.

Koromondy(1960) found no significant differences between the overt and the covert response modes. Sidowski, Kopstein and Shillestead (1961) found that the covert response proved more efficient than the overt when both the time and amount of learning were taken into account. Silverman and Alter (1960) found that students who simply read items learned significantly more than students who read items and responded actively. Stolurow and Walker (1962) found no significant difference between learning from writing responses or merely thinking them. Of course covert responses required less time than overt. Leith and Guhman (1966) found no significant differences between the four treatments selected for the present inquiry. They noted that there was an appreciable Response-mode Answer interaction—the covert constructed response mode being significantly better than the overt constructed response mode while the two answer groups were not different.

Nevertheless, there are certain thought provoking results regarding the question of overt-covert affairs, for example, the one by Cummings and Goldstein (1962) showed that the group which wrote answers scored higher on both the verbal and pictorial materials and on both immediate and delayed tests than a group which was told merely to think. Of course, the covert responders took less time, average 50 minutes, than the overt group which required 96 minutes. It may be that the complexity of the topic (it is about medical diagnosis) made for an advantage to the students who took longer and practised writing the response.

Krumboltz and Weisman (1962 b), on the other hand, found no significant difference on an immediate post-test between a group which wrote answers and a group which only composed answers mentally; but on a retention test after two weeks, there was a significant advantage to the overt responders. Thus, this study is suggestive that the additional practice of writing an answer contributes to retention of some subject matter.

There is support elsewhere in the literature (Angell and Lumsdaine, 1961) for the view that it is important for the student to actively make a correct response, before going to the next step.

Eigen and Margulies (1963) compared material at three difficulty levels (or rather amounts of information required to make a decision) responded to either overtly, or covertly by tests of incidental and relevant learning. They found that 'the further the material is from the repertoire of the student the more important is the requirement of an overt response'. The two higher levels of difficulty were learned more successfully by overt responding when tested for relevant responses. The lowest level was the same for both methods.

Studies with Programmes Containing Responses Already Filled In

The studies comparing the active response versus mere reading of items containing correct responses are somewhat equivocal. Holland (1960), for example, found that a group which just read the complete statements (i. e. the answers already inserted in the blanks) made more errors than either active or covert responders on a final test, but took less time to complete the programme.

In two experiments, Silverman and Alter (1962) found non-significant differences between a group which read complete items and another group which read and then responded actively. On a third experiment, however, they found significant differences in favour of the group that merely read the items.

Campbell (1961) studied the effectiveness of the following four conditions:

(1) Subjects wrote in the response only when sure of its correctness.

(2) Subjects wrote answers in every blank.

(3) Subjects did not write answers but mentally composed answers.

(4) Subjects read the same frames with no words omitted—no blanks to fill.

On the immediate post-test there was no significant difference among the means of the four groups. Ten weeks later, condition (4) was better than others at 0.05 level. The expectation that condition (1) would make for more learning and same time, was not supported. Condition (1) resulted in fewer errors, but these did not show up in learning effect.

The experiment by Goldbeck and Campbell(1962) is a step further in this direction in the sense that it tested materials at different levels of difficulty. It was found that overt responding was superior to mere reading at an intermediate level of difficulty, but naturally took more time. There was no significant difference at the most difficult and easiest levels. However, in their second experiment, they found the reading group to be superior on a retention test administered 10 weeks later.

Pressey (1963) tested the first unit of the Holland–Skinner Psychology programme against the same material rewritten into good prose paragraph. He found no significant difference in learning, although reading the prose took less time than working through the programme. When he added some of his typical review questions to his prose material, the amount of learning was higher, but still not significantly so than the learning from the programme.

The earlier investigators like Feldhusen and Birt (1962) Cropper and Lumsdaine (1962) found non–significant differences between reading and responding group.

G. O. M. Leith and Guhman (1966) in a recent study comparing overt and covert responding with and without answers given in the blanks found the covert construct response group to be consistently the better.

Tuel's study (1964) is, of course, rather different from the others in the sense that it aimed at determining the relative teaching effectiveness of overt vs. covert responding under varying conditoins of IQ, sex, item difficulty, retention interval learning time, test time, response precision, and so on. No significant difference in general achievement or efficiency of retention was found. The interesting finding is that the overt response group did learn significantly more of the difficult material for brief retention, and at moderate precision, than did the covert group, but at high precision, even this difference dropped below significance level.

Another related study by Tuel and Metfessel (1965) made it clear that the overt response mode did not prove superior to the covert response mode in teaching effectiveness except for rather difficult material when only short-term retention was desired. Thus, in the interests of maximum learning efficiency it would appear that the requirement to respond overtly, now a part of most programmes, should be relaxed or abandoned for all but the most difficult material or the one for which the student does not have satisfactory prerequisite knowledge.

Shah (1971), comparing overt and covert forms of construct response type or prompting (i. e. answer given in the blank), found that the group which just read the frames with answers written in the blanks proved to be more effective both on immediate test scores and time factor.

Holland made an interesting study as early as 1960 regarding the cruciality of the required response. He prepared three more new versions—one with blanks for responses of a trivial and easy nature; a second one with blanks which actually made the items ambiguous and difficult; and the third one with blanks filled with responses thus making it a statement form. The group using the normal version of the programme (in which the blanks required the student to notice the critical material) did better than the others. This demonstrates that overt response is meaningful only when it facilitates the student in noticing the critical information of the material, otherwise, trivial items, whether overt or covert do not yield any fruitful or guiding suggestions in the realm of research in programming.

Studies Comparing Linear and Branching Programmes

A common question that both the programmer and the programme user face is ' linear or branching' ?

Though research using adults as subjects, for example the one by Roe (1962), failed to show any significant difference in the effectiveness between linear and branching programmes, there are certain peculiar observations made. For example, the studies by Coulson and Silberman (1960) or the one by Fry (1960) have found constructed response programmes giving higher scores on a test of recall, though there is no difference when recognition tests are used.

Of course there are studies here too, just like the one by Larkin and Leith (1963) wherein with junior school children of below ten years, the constructed response group fared better than the branching group on both kinds of tests (i. e. recall and recognition). In keeping with the view of 'conceptual structures' the linear was more effective for the low-ability levels, though the brightest children performed equally well with either programme. Secondly, the linear group was better on a four months retention test also. When Larkin (1964) repeated the experiment with fourteen year olds of a secondary school, there were no differences between linear or branching methods of programming on an immediate post-test or a retention test after four months.

Campbell (1962) found that by-passing form (which allowed subjects to skip upto 85 per cent of learning material as a consequence of correct responses to fifteen basic steps) was no more efficient than the linear methods, regardless of mathematical ability level.

Householder's study (1964) is also of the no significant difference type in the achievement of students following linear or branching programmes. Clearly, groups receiving linear programme required the greatest amount of time.

An earlier study by Beane (1962) comparing the linear and branching forms showed that a branching programme was more efficient than the linear programme, timewise only. The important finding however, was that the students expressed more favourable attitudes to the linear programme.

Branching programmes contain remedial information and so may be thought to be useful for a wider range of ability. However, it has been found by investigators like Knight (1963), Wallis and Wicks (1963), Larkin and Leith (1963), etc., that the correlation between ability and test score after learning from a branching programme was usually quite high, whereas in a high proportion of cases, for example as found by Larkin and Leith (1963), Cresswell (1964) and Middleton (1964) etc. where linear programmes have been used, the correlation is lower. Thus, it appears that many programmes are not suitable for a wide range of ability.

Leith (1966) points out a practical disadvantage of branching forms—" Branching Programmes have an unexpected difficulty. The learner is intended to read the 'information' provided, then the question, and finally select an answer. Many learners, however, (including young children) acquire a set to read the question first and choose an alternative without going through the instructional part of the frame. This may, of course, merely speed up the pace but a motive for it may well be classroom competitors and the result lower performance or retention." Of course, this difficulty may be overcome by using a machine which exposes the question only after the student reads the information.

Observations From Earlier Studies

(a) Relatively few studies use branching programmes.

(b) The value of overt response depends on the difficulty level of the frame and the familiarity of the content.

(c) Branching programmes take less time to work through than linear programmes.

(d) Research work into programmes of a hybrid nature, that is, combining the characteristics of both the linear and branching forms is practically nil.

(e) Retention tests are important while evaluating the efficiency of a programme.

Implications

All the above researches and findings make the investigator feel that students do learn by ways other than the step-by-step characteristic of Skinnner. Branching programmes take too wide a jump and the selection of a correct choice from a multiple choice question may not guarantee that all the earlier steps have gone into the conceptual structure of the student. Also, there arises a situation wherein the error of some students may be clarified by branching them to another mass of material while others require small frames each time they make a mistake. All these led to the preparation of hybrid programmes and skip programmes by the investigator.

STATEMENT OF THE PROBLEM

"An Investigation into the Relative Effectiveness of Different Forms of Programmed Learning Material."

HYPOTHESES

It has been hypothesized that :

(i) there will not be any significant difference in the achievement of different treatment groups on the immediate post-test

(ii) there will not be any significant difference in the achievement of different treatment groups on the retention test.

MATERIALS PREPARED

The investigator undertook the responsibility of preparing the different forms of programmed learning materials.

The forms differ in certain aspects like step-size. mode of response, utility and manipulation of errors, etc. But all have the same entering behaviour and terminal behaviour. A common criterion test was prepared to measure the success or otherwise in achieving the terminal goals. A programme on 'Thermometers' was prepared in seven different forms namely :

A. Linear Overt Form
B. Linear Covert Form
C. Response-Prompt Writing Form
D. Response-Prompt Reading Form
E. Skip-Programme Form
F. Branching Form
G. Hybrid Form (Branching-Linear Form)

An Entering Behaviour Test was prepared for the validation of the programme.

DESCRIPTION OF THE TREATMENTS

(A) **Linear Overt Form**

This is the traditional Skinnerian programme containing frames of small steps and having blanks or questions. The response should be of construct type or requiring the student to select one of the alternatives provided. The student is expected to write down his answer.

(B) **Linear Covert Form**

This is the Linear Form described above, but requires the student to think about the answer without writing it down.

(C) **Response-Prompt Writing Form**

This is the linear programme with answers given in the blanks so that the student is prompted with the answers rather than constructing the answer. The student is expected to copy down the word or answer given in the blank.

(D) Response-Prompt Reading Form

This Response-Prompt Form differs from the one described above in that the student would silently read the frames instead of doing any overt response like copying the answer.

(E) Skip-Programme Form

In this form each sub-concept starts with a terminal frame. If the student's response is appropriate, he will skip over some frames in between and will go to the next sub-concept. If his response is wrong, he will be led to further elaboration of that point through the regular frames and then will go to the next sub-concept.

Forms A, B, C, D and E all contain small frames of linear type whereas Form E, in addition, contains some frames like......

"If your answer is **Yes**, go to frame No. 68.
If your answer is **No**, go to frame No. 72."

...... in order to direct the student according to his response. In this respect, Skip-Programme Form facilitates the student to branch off according to his response.

(F) Branching Form

This is the typical branching programme advocated by Crowder. Each concept is elaborated in a paragraph or two of about ten lines which is followed by a terminal question of multiple choice type. Each alternative is provided with a different page number which should be followed by the student according to his choice. If his choice is right he is led to the next concept. If he makes an error, he is led to remedial information and then he is asked to read the question again. Here the student is expected to write down his choice.

(G) **Hybrid Form (Branching-Linear Form)**

Here the student who commits an error branches off to a series of linear frames wherein the concept is elaborated and explained. These remedial frames are just the same as the linear overt frames and the student answers each and every frame. The remedial sequence terminates with a direction leading to the next concept. This form also requires an overt response i. e. writing down the answers. Forms A, B, C, D, E and G consist of frames of small steps (in G they are the remedial frames).

Forms A, C, E, F, G require overt responses i. e. writing down the answer while B and D require just thinking or reading the frames.

Forms E, F and C consist of branches according to the response made.

THE INVESTIGATION

Preparation of Programme Forms

Due to lack of suitable forms of programmes, the investigator decided to prepare different forms of the programme on 'Thermometers'. The preparation of the programme forms involved the following steps :

(a) deciding the entering behavioural requirements and constructing the Entering Behaviour Test;

(b) deciding the terminal objectives and construction of the Criterion Test on the basis of the terminal objectives;

(c) task analysis and content analysis;

(d) preparation and editing of the programme forms;

(e) individual try-out of the programme;

(f) revision and re-editing of the programme; and

(g) group try-out—analysis and evaluation of the final forms in terms of the criterion test scores.

Table: 1 COMPARATIVE ANALYSIS

Sr. No.	Programme Forms	Step size	Construct/ Multiple choice	Mode of response
1	Linear Overt	Relatively small	Construct	Writing
2	Linear Covert	Relatively small	Construct	Mentally thinking
3	Response-Prompt Writing Form	Relatively small	Construct	Copying
4	Response-Prompt Reading Form	Relatively small	Construct	Reading
5	Skip-Programme	Relatively small	Construct, but multiple choice on criterion frames	Writing
6	Branching form	Relatively large	Multiple choice	Writing
7	Hybrid form	Large in main stream and small in remedial frames	Multiple choice in main stream and construct in remedial frames	Writing

OF THE TREATMENTS

Expectation of errors	Knowledge of results	How errors are handled
Less errors	Only correct answer	Just correct answers shown; he then goes to the next frame.
Less errors	Only correct answer	Just correct answers shown; he then goes to the next frame.
Less errors	Only correct answer	Just correct answers shown; he then goes to the next frame.
Less errors	Only correct answer	Just correct answers shown; he then goes to the next frame.
Errors permitted to some extent	Only correct answer	At criterion frames, correct answer makes the pupil to skip some frames; wrong answer leads to further elaboration of the point.
Maximum use of errors	Correct answer + reason why it is correct or wrong.	Remedial frames and back to original question.
Maximum use of errors	Only correct answer in remedial frames.	Remedial frames of linear type and forward to next main stream point.

Classification of Variables

(a) Independent Variables

The experimental treatments are the forms of the programme on 'Thermometers'. They include :

(A) Linear Overt Form

(B) Linear Covert Form

(C) Response-Prompt Writing Form

(D) Response-Prompt Reading Form

(E) Skip-Programme Form

(F) Branching Form

(G) Hybrid Form (Branching-Linear Form)

(b) Intervening Variables

In an experimental study of this type many intervening variables can be considered : socio-economic status, grade level, intelligence level, scholastic achievement in science, prerequisite knowledge about the lesson.

In the present study, grade level was held constant by taking the sample from the VIIIth standard only. Socio-economic status could not be known precisely because the overseas students and students from outside Baroda could not give family backgrounds accurately. As the sample consisted of English medium schools of a fee-paying population, it was assumed that the sample consisted of the students of the upper-middle class. As the students were randomly divided into seven treatment groups it was assumed that socio-economic status and age were taken care of. Finally, the investigator came down to the following variables :

(i) Intelligence

(ii) Scholastic achievement in science.

As intelligence was found to correlate significantly with scholastic achievement in science, it was decided to just control the IQ by using the technique of analysis of covariance.

(c) Dependent or Criterion Variables

The efficiency of the different forms of the programme were assessed on the following criteria :

(i) Immediate post-test score

(ii) Retention test score.

Tools

The following tools were used in the present study :

(a) Forms A, B, C, D, E, F and G of the programme on 'Thermometers'.

(b) Entering Behaviour Test.

(c) Criterion Test.

(d) Shah's Non-Verbal Intelligence Test.

Sample

A programme on Thermometers (unit of IX std.) was prepared and then seven forms were derived from the programme. The programme was given to the students of std. VIII because it was found that in some schools it was already covered. There are about ten English medium schools (secondary) in the city of Baroda and out of these only nine have std. VIII. The investigator managed to get cooperation from eight out of the nine schools eligible to be included in the sample.

All the students from all the above mentioned schools were included, though at the end, there was a reduction in the sample size due to wastage. The sample consisted of 322 students drawn from eleven classes of std. VIII and there were 46 students in each treatment group.

Procedure

First Phase

The experiment was conducted separately in each class of the sample. The class was first randomly divided into seven groups in order to assign one treatment to each group. Care was taken that there were equal number of students in each group. The subjects were instructed to go according to their own speed and it was made clear that they need not race through the work because it was not meant to compare one individual with another. The time taken by each subject was noted in order to get the average time taken by each treatment group. Immediately after finishing the programme, the criterion test was administered the score of which was taken as one index of the efficiency of the programme.

It is worth mentioning that the oral instructions for the programme and for the criterion test for all the groups were given personally by the investigator himself. The programme administration included a rest pause in order to minimise fatigue.

Second Phase

As the literature survey emphasised the necessity of comparing the treatments in terms of retention as well, the criterion test was readministered after a lapse of six weeks and the score of this was taken as the second index of the efficiency of the programme. Besides, the percentage of retention was calculated as the third index of the effectiveness.

Experimental Design

Random replication design was followed in the study. The students of each class were randomly allotted, in equal numbers, to each of the seven groups. In each class students worked simultaneously in one of the seven groups. The procedure was replicated in all the classes. Scores on immediate post-test and retention test were found out for each student.

STATISTICAL ANALYSIS

This is an experimental study and it was felt that the groups might be initially unlike with regard to mean IQs. The investigator calculated the mean IQs of all the seven groups and found them to be obviously different. It was in the light of these obvious differences that it was decided to go for statistical control. So it was decided to analyze the data using the technique of analysis of covariance which allowed for adjustments in the initial scores.

The statistical analysis using the analysis of covariance was carried out comparing the different treatments with respect to immediate test scores and retention scores.

Below are given the group means of the seven programme forms in terms of the immediate post-test, percentage of retention, etc.

Table 2 : Mean Scores of Subjects in Seven Treatment Groups on Immediate Post-Test and Retention Test.

	Linear Forms		Response-Prompt		Skip Programme	Branching	Hybrid
	Overt	Covert (Thinking)	Overt (Writing)	Covert (Reading)			
	A	B	C	D	E	F	G
Immediate Post-Test	28.36	30.39	28.10	31.19	28.78	27.43	28.56
Retention Test	26.84	27.15	25.69	28.00	25.60	25.36	26.50
Less	1.52	3.24	2.41	3.19	3.18	2.07	2.06
% of Retention	94.64	89.34	91.42	89.77	88.95	92.45	92.79

Observations

Immediate Post-Test and Retention Test

(1) Group D, using Response-Prompt Covert Reading Form, is better than all the others both on the immediate post-test and the retention test.

(2) Group F, using Branching Form, is the lowest in efficiency in terms of both immediate post-test and the retention test.

Percentage of Retention

(3) When the percentage of retention is considered, group D no longer retains its superiority obviously because it is the one with more 'loss', i. e. 3.19 points, next to group B on 'loss'.

(4) The same trend is seen in group B with Linear Covert Thinking Form which suffers maximum loss of 3.24 points.

(5) The same is the case with group E using the Skip-Programme, which, though the third in order of achievement on the immediate post-test, is also the one with higher 'loss' i.e. 3.18 points.

Implications

The percentage of retention, as another measure of comparison, indicates that both the covert groups, i. e., group B with Linear Covert (Thinking) Form and group D with Response-Prompt Covert (Reading) Form are the groups with highest 'loss'. This fact may perhaps indicate that something is crucial about the very nature of a covert response.

This fact has a supporting observation indicating that groups like group A—using the typical Skinnerian linear form, or group F—using the typical branching form or even group G—using the hybrid form with main stream of branching type and remedial frames of Skinnerian type, allow lower 'loss'. Perhaps this may suggest that there is something inherent in the overt response (that too of the type requiring 'answers' rather than 'copy') facilitating better retention. This fact, if established, will contribute to refining the progammes with a covert type of response so that they retain better.

In Table 3 is given the rank order of the seven programme forms in terms of the immediate post-test and the percentage of retention.

Observations

(1) Group D with Response-Prompt Covert (Reading) Form, group B with Linear Covert (Thinking) Form and group E with Hybrid Form and group F with Branching Form retain their relative ranks in terms of scores on immediate post-test and retention test, but the percentage of retention is different from group to group, wherein the 'Hybrid' retains a higher percentage followed by Branching.

(2) Comparison of the Two 'Overt' Forms

It is very interesting to note that Linear Overt Form is better than the Response-Prompt Overt (Writing) Form in terms of both the immediate post-test, with Linear Overt 28.36, Response-Prompt Overt 28.10, and the percentage of retention with Linear Overt 94.64, and Response-Prompt Overt 91.42.

(3) Comparison of the Two 'Covert' Forms

Surprisingly, the comparison of 'Covert' forms yields just the reverse situation wherein the Response-Prompt

Table 3 : Rank Order of the Seven Treatment Groups on Immediate Post Test, Retention Test and Percentage of Retention

Immediate Post Test			Retention Test			Percentage of Retention		
Response Prompt Covert (Reading)	31.19	I	Response Prompt Covert (Reading)	28.00	I	Linear Overt	94.64	I
Linear Covert (Thinking)	30.19	II	Linear Covert (Thinking)	27.15	II	Hybrid Form	92.79	II
						Branching	92.45	III
Skip-Programme	28.78	III	Linear Overt	26.84	III	Response Prompt Overt (Writing)	91.42	IV
Hybrid Form	28.56	IV	Hybrid Form	26.50	IV			
Linear Overt	28.36	V	Response-Prompt Overt (Writing)	25.69	V	Response-Prompt Covert (Reading)	89.77	V
Response-Prompt Overt (Writing)	28.10	VI	Skip-Programme	25.60	VI	Linear Covert (Thinking)	89.34	VI
Branching	27.43	VII	Branching	25.36	VII	Skip-Programme	88.95	VII

Covert (i. e. Reading) Form is better than the Linear Covert (i. e. thinking) Form both on the immediate post-test with Response-Prompt Covert 31.19, and Linear Covert 30.19, and the percentage of retention with Response-Prompt Covert 89.77, as against Linear Covert 89.34.

(4) Comparison of the 'Branching' Forms

Skip-Programme Form and Hybrid Programme Form can also be considered to be branching as they allow flexible routes to be taken by the student according to the responses made. It is worth noting that on the immediate post-test they come out almost equal with means of 28.78 for the Skip-Programme group and 28.56 for the Hybrid Form group, while on the percentages of retention they differ widely where Hybrid Form facilitates 92.79 per cent of retention while Skip Programme Form just 88.95 per cent.

(5) Comparison of the Two 'Linear' Forms

This comparison provides a still more surprising observation where the Linear Covert is better on the immediate post-test than the Linear Overt (30.19 and 28.36, respectively), while the reverse is true in terms of percentages of retention wherein Linear Overt facilitates 94.94 percent of retention while the Linear Covert just 89.34 per cent.

(6) Comparison of the Two 'Response-Prompt' Forms

This is just like the trend observed in the two linear forms. Here also, the Covert Response Prompt (Reading) is better than the Overt Response Prompt (Writing) on the immediate post-test i.e. 31.19 and 28.1, respectively.

The results are quite the reverse in terms of percentages of retention where the Overt Response Prompt group retains 91.42 per cent as against the Covert Response Prompt group with 89.77 per cent of retention.

Implications

The implications of these comparisons throw some light on the nature and workability of the programme forms. Immediate test scores no longer remain a perfect criterion of efficiency because a programme form may come out to be successful on the immediate post-test but fail to facilitate retention in the long run. Thus one can no longer worship linear as a 'panacea' or throw away branching as inefficient. Still, the observation that Linear Overt is better than Response Prompt Covert in terms of immediate post-test and retention and even better than linear covert in terms of percentage of retention, clearly indicates its worthwhileness.

At the same time, the Covert Response-Prompt is better than Covert Linear both on immediate post-test and percentage of retention and even better than Overt Response-Prompt, at least on the immediate post-test.

All these indicate the importance of retention tests on one hand and the need for further probes into the characteristics of the programmes (whether the linearity or branching of it or Overt or Covert Response) facilitating comprehension and retention.

The general comparisons of the groups in terms of percentages, means, frequency distribution or rank orders facilitate a quick perception of the general trend of the groups but fail to indicate whether the differences observed are statistically true and significant or are just due to chance fluctuations. So the investigator preferred to study the groups in terms of a more sophisticated method of analysis, that is, the 'analysis of covariance in duplicate experiments in randomly selected schools', described at length by Lindquist (1970). The distinguishing characteristic of any analysis of covariance is that it takes care of any possibility of the initial differences i. e. in terms of IQ or achievement in science etc. influencing the final differences of the groups on immediate or retention tests. This was felt necessary because the groups were not matched in terms of initial scores. Also, it gives a quantitative picture by making it further specific by revealing the levels (.01 or .05) at which these differences exist. The special feature of this design of duplicate experiments is that the class variations are also given due consideration so that the inferences cannot be just misleading thus masking the effects of classes (i. e. the classes selected from different schools).

Table 4 gives the analysis of covariance for the immediate post-test.

Observations (Table 4)

It can be seen that the overall differences between the seven treatment means are significant at .05 level. As the differences among the schools have been statistically controlled by utilizing Lindquist's design of 'analysis of covariance' in duplicate experiments in randomly selected schools, it can be inferred that the differences among the treatment groups are true differences and are neither due to initial differences which are indicated by the negative value of sum of products for methods as -168.74, nor due to school to school variations which are controlled by the very design of covariance.

Table 4: Analysis of Covariance of the Immediate Test Scores for the Seven Treatment Groups (Taking IQ as the Initial Score)

	x^2	xy	y^2	S. S.	df	F	Significance
M	150.74	−168.74	489.04	616.69 (reduced S.S.)	6	2.99	Significant
M x S	4323.01	1533.55	2566.68	2022.67 (adjusted S.S.)	59		at
M+(MxS)	4473.75	1364.81	3055.72	2639.36 (adjusted S.S.)			.05 level

Table 5 : Analysis of Covariance of the Percentage of Retention Scores for the Seven Treatment Groups (Taking IQ as the Initial Score)

	x^2	xz	z^2	S.S.	df	F	Significant
M	150.74	-36.44	630.72	648.09 (reduced S.S.)	6	0.48	Not Significant
M x S	4323.01	1779.49	14691.41	13958.92 (adjusted S.S)	59		
M+(MxS)	4473.75	1743.05	15322.13	14643.01			

Hence we can safely reject the null hypothesis and attribute the differences to the variations in programme forms.

Table 5 gives the analysis of covariance for the retentions.

Observations (Table 5)

It can be seen that the overall differences between the seven treatment means are not significant even at .05 level. As the differences among the schools have been statistically controlled by the design used and as school variations are also controlled, it can safely be inferred that there are no true differences among the treatments in terms of the percentage retained.

Hence the null hypothesis is retained indicating that the programme forms do not differ statistically in terms of the percentage of retention.

Table 6 gives the analysis of covariance of time.

Observations on Time

It can be seen that the overall differences between the seven treatment means are significant at .01 level. As the differences among the schools have been controlled statistically by the design used, the null hypothesis can be rejected and the differences can be attributed to the programme forms rather than to the chance factors.

Table 7 gives a summary table comparing the various programme forms in terms of the observations made and the F values obtained.

Table 6 : Analysis of Covariance of the Time (in minutes) Required by the Seven Treatment Groups to Finish the Programme (Taking Intelligence as the Initial Score)

	X^2	XT	T^2	S.S.	df	F	Significance
M	150.74	–380.29	12913.04	13046.04 (reduced S.S.)	6	4.59	Signi-
M x S	4323.01	932.60	28115.48	27914.30 (adjusted S.S.)	59		ficant at
M+(MxS)	4473.75	552.31	41028.52	40960.34 (adjusted S.S.)			.01 level

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Table 7 : Summary of Observations Made in the Comparative Study of Programme Forms

	Immediate Post-test			Percentage of Retention		
1. Ranking of the relative Programme Forms	R. P. Covert	(D)	31.19	Linear Overt	(A)	94.64
	Linear Covert	(B)	30.19	Hybrid	(G)	92.79
	Skip programme	(E)	28.78	Branching	(F)	92.45
	Hybrid Form	(G)	28.56	R. P. Overt	(C)	91.42
	Linear Overt	(A)	28.36	R. P. Covert	(D)	89.77
	R. P. Overt	(C)	28.10	Linear Covert	(B)	89.34
	Branching	(F)	27.43	Skip-Programme	(E)	88.95
	On Immediate Post Test & Retention Test			**On the percentage of Retention**		
2. High Scoring Form	Form D			Form A		
3. Low Scoring Form	Form F			Form E		
4. Analysis of Covariance	2.99			0.48		
F Test	Significant at .05 level			Not Significant		

To sum up, it can be seen that the immediate post-test has the potentiality to distinguish the forms in terms of their relative efficiencies, and that too, to a level significant enough to be relied upon. In the present study, the immediate post-test supports the efficiency of the programme of Response-Prompt Covert Form in which the answers are already given and the student has just to read each and every frame. The LSD test following the analysis of covariance also supports its individual merit in terms of individual comparisons with all other methods. But the Branching Form which is the least effective in terms of immediate post-test, does not significantly differ to a high degree with at least certain forms like Linear Overt, Skip-Programme, etc.

The retention test is not very effective in bringing up a crystal clear picture of the most efficient form. Taking the percentage of retention, D is no longer the form with high percentage of retention. On the other hand, other forms, though not the ones with high scores on immediate post-test, facilitate the retention of whatever has been learnt.

Thus, no final word can be said regarding the most efficient form if one considers the double criteria of immediate post-test and percentage of retention. But this suggests two things namely, (i) immediate post-test alone cannot become the criterion of efficiency, (ii) the retention test should also become a part and parcel of the development of the programme itself i. e. in the individual tryout and group tryout stages, in order to justify the aim of maximizing the efficiency of the programme. Otherwise, it would become as questionable and misguiding as the ambiguous item of an intelligence test which reads, 'When I needed 2 marbles, Ram gave me 4, so when I need 5 marbles Ram would be giving______,' the answer of which can be either 7 (i.e. two extra), 10 (double) or even 25 (the square) according to the logic followed which cannot be disputed because the sequence of the item is incomplete.

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5

Relationship Between Personality Variables and Achievement of Pupils on Programmed Learning Material

— Here is a study undertaken to investigate how effective the programmed learning materials are with pupils having different personality characteristics. A sample of 525 pupils of standard VIII was taken from eleven Gujarati medium schools of the City of Baroda. One linear programme in Science and one branching programme in Geography were given to the pupils along with Bernreuter's Personality Inventory, IPAT Anxiety Scale and Intelligence Test. The achievement on programmed learning materials was judged in terms of the scores obtained by the pupils on the criterion tests (of both the types of programmed learning materials) given immediately after completing the programmes and after an interval of two months. Partial correlations between programme types and selected personality variables were computed which showed significant relationships between both types of programmes and intelligence. Anxiety correlated negatively with the achievement on the linear programme. Self–sufficiency and introversion–extraversion did not influence the achievement on any of the two types of programmes. The findings of the investigation supported the general assumption that the achievement on programmed learning material is least affected by the personality characteristics of the learners.

Programmed learning, though not a new concept, has attracted many because of its effectiveness and multifarious use not only in the field of education but in other fields as well.

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The effectiveness of programmed learning technique, in terms of pupils' achievement and its efficiency in terms of time taken to learn a particular topic, has been proved by studies in India as well as abroad.

A study conducted by Little (1934), Angell (1949) and Peterson (1960) revealed that prompt knowledge of results enhances the students' capacity to learn. Dorothy (Ofiesh & Meierhenty, 1964) found in her study that programmed learning material can bring significant reduction in time. Shah (1963) found that the experimental group taught through programmed material achieved more in less time.

Studies have also revealed the possibility of the use of programmed learning for learners at different levels. Moore (1962) was able to accomplish remarkable success in teaching two and three year olds to read and type. Stolurow (1961) obtained corroborative data in teaching retarded children a sight vocabulary. Krishnamurthy and Thiagarajan (1967) successfully administered the Picto-program on Condom Utilization on illiterates.

Inspite of all the supporting evidence programmed learning has its limitations. Every human being is a product of a genetic endowment and an environmental history which are peculiarly his own. With this in mind, Fusco (1962) wrote that a particular programme may not be optimally effective for a heterogenous class. An ideal sequence of items for one student may be less effective for another. Keeping in tune with Fusco's opinion are the results of an experiment conducted by Reed and Hymann (1962). When the results of a grammar programme were analysed at three ability levels, the highest ability group, starting with the highest pretest scores, learned most; the lowest ability level, which had the most to learn, gained the least. The post-test achievement of the lowest group did not even surpass the pretest achievement of the middle ability level. Gotkin (1964) attaches the problem of boredom to the failure of programmed instruction to mitigate differences in achievement. There may be other factors affecting the achievement of pupils on a programme.

Emphasising the importance of individual differences in modern education, Suppes (1964) stated that improvement in learning of subject matter could best be achieved through research concentrated upon individual differences. Since these differences imply that each learner will proceed at his own pace, only teachers utilizing technological methods can achieve this individual pacing.

Taking a clue from the above mentioned studies, it was thought necessary to study how far programmed learning helps in catering to individual differences among learners, before it is introduced in the mainstream of the educational system of our country.

STATEMENT OF THE PROBLEM

The problem of the investigation was stated as follows: " To Study The Relationship Between Personality Variables And Achievement Of Pupils On Programmed Learning Material (PLM)."

The personality variables studied were as follows:

1. Intelligence
2. Anxiety
3. Self-sufficiency
4. Introversion-extraversion.

As regards the achievement on programmed learning material, the following four measures were taken:

1. Immediate Score on the Criterion Test (Linear Programme).
2. Retention Score on the Criterion Test (Linear Programme).
3. Immediate Score on the Criterion Test (Branching Programme).
4. Retention Score on the Criterion Test (Branching Programme).

RELATED STUDIES

Some recent studies have taken into consideration the learners' characteristics and personality variables while studying the effectiveness of PLM. Glancing at the researches done in the area of learning, one can find a number of studies regarding personality and academic achievement. Before reviewing the research related to personality variables and PLM, it is worthwhile reviewing the researches about personality and academic achievement in general.

Personality and Academic Achievement

Ashammer and Shain (1970) studied different personality dimensions as prediction of school achievement. Their study revealed that different personality dimensions differentially predict school achievement at different age levels. Intelligence had the highest correlation with the achievement whereas with respect to personality factors, age, strength, surgency and self-sentiment were significantly related to the criterion. Guilt-proneness correlated negatively with the criterion.

Lachica (1969) studied the relationship between factors of personality and achievement of selected groups of tenth grade students. His findigs showed low correlation between the personality factors or dimensions and the achievement criteria. The factors motivation, intellectual interests, closeness and orderliness and the dimensions intellectual orientation, dependency needs and educability tended to be positively associated with academic performance, while the factors self-assertion, submissiveness, friendliness, sensuousness, expressiveness-constraint, and egoism-diffidence and the emotional expression dimension tended to be negatively associated with academic achievement. Only 7 of 24 multiple correlations of achievement with personality factors, and 5 of 24 multiple correlations with personality dimensions were statistically significant.

Sarson (1957) found significant negative correlation between 'test anxiety' and measures of scholastic aptitude, but a significant positive correlation between 'general anxiety' and college grade point averages.

Cook (1959) found that honours students with lower scholastic ability had significantly more anxiety than those with high ability.

Basu (1970) selected two more personality factors, namely neuroticism and extraversion, and found that the scores on these two traits are significantly related to academic performance.

Srivastava (1966) studied personality factors related to educational underachievement. Significant correlation between adjustment and achievement scores was indicative of the trend of poorly adjusted pupils to be poor achievers. He also studied the relationship between insecurity and achievement and concluded that low security is the characteristic of the high achieving group, and vice-versa.

Jamuar (1961) investigated some psychological factors underlying study habits of college students. His findings indicated that achievement bears a significantly negative association with extraversion scores. Stated differently, there exists a positive relationship between introversion and achievement.

Finlayson (1970) studied the relationship between extraversion, neuroticism and the school achievements of a group of 128 boys at the ages of 12, 13 and 14 in a grammar school. In the 11 t tests, no systematic differences between the groups were noted, but once, in the secondary school introverts obtained progressively higher marks in yearly examinations than extroverts. In introverts, low neuroticism is consistently associated with better achievement while in extroverts, high neuroticism steadily depresses academic performance over the three years to give a significant overall effect in the third year. If the achievements of only the two high neurotic groups are considered, introverts tend to improve with age while extroverts deteriorate.

The studies cited above reveal the following :

1. Intelligence is highly correlated with the academic achievement.
2. The findings related to the relationship between anxiety and achievement are contradictory. Some studies reveal that anxiety is positively correlated with achievement whereas others reveal that it is negatively correlated with achievement.
3. Poor adjustment and high security are the characteristics of the low achieving group.
4. Introversion is positively related to achievement.
5. Introverts with low neuroticism achieve better and they tend to improve with age.

The above mentioned studies and many others indicate that personality factors do contribute significantly to one's academic achievement. Shifting the attention from academic achievement in general, to achievement on PLM in particular, it would be interesting to know in what way different personality variables contribute to the achievement on PLM.

Personality and Achievement on PLM

Fishman's (1962) study revealed that personality factors do not contribute significantly to the variability in the prediction of academic performance.

Davis and Banning (1968) made an attempt to predict which types of students would profit most from programmed instruction. The independent variables were personality types as defined by the Personality Assessment System (PAS) and by attitudes held toward programmed instruction and education as measured by Semantic Differential. The dependent variables were scores on the programmed instruction test and the course grade. The sample consisted of 97tenth and eleventh grade students in a basic mathematics course.

The results revealed that the PAS personality patterns were overshadowed in their predictive ability by attitudes. Final grades were most influenced by attitudes toward teachers and school. None of the deviations of the hypothesized personality patterns resulted in a significant degree.

A three part study conducted by Woodruff, Faltz and Wagner (1966) reported significant relationship between performance on PLM and learning ability. In part one of the study it was found that "Fast", "Average", and "Slow" learner groups (1) completed the programmes in order of their ability, and (2) had an average number of correct responses in the order of their learning ability. In part two of the study, the number of correct responses produced in a spelling programme were compared between matched pairs. Each pair consisted of a learner from a high reading level group and a learner from a low reading level group. Of the thirty comparisons made, only one failed to show a markedly higher number of correct responses in favour of learners from the high reading group. Part three of the study involved three personality measures for 26 ninth graders who worked on a programme on Biology. The measures taken were Edward Personality Preference Schedule (EPPS), the Gordon Personality Inventory (GPS), and the James Internal External Scale (JIES). From the EPPS, only the need to achieve had a significant relationship to performance (number of correct responses). All five of the GPS measures were significantly related to performance whereas none of the JIES measures were found to be significant. As the programme utilized was relatively short, these relationships could not be regarded as definitive. They did, however, indicate functional relationships between performance and the personality characteristics of learners.

Dick and Seguin (1963) studied whether personality pairing of learners (pairs having similar or dissimilar dominant and submissive traits) contributes differentially to performance on a programmed course. Fifty six entering freshmen were given the programme on English grammar. Besides other tests of English, ability etc., Bernreuter's Personality Inventory was used as a measure of personality.

The analysis revealed that the Dominant–Similar Group showed a more favourable attitude toward the programmed course than the Submissive–Similar Group. Considering the contribution of the interaction between personality type and pairing procedure, of the 48 possible comparisons only two were significant.

How a learner reacts to making or avoiding errors depends on his personality. It is probable that people of different temperaments either thrive on errors and fade when in a highly prompted situation, or the reverse, which was what Leith (1968a) suggested in his paper.

Woodruff and Shimabukuro (1965) studied the basic issue, i. e., "Does programmed instruction provide adequately for individual differences among learners ?" This problem was pursued in this study on the basis of four measures: (a) frequency of repeated errors, (b) frequency of high error frames classified as the type of prompt utilized in it—formal or thematic, (c) frequency of boredom symptoms and (d) frequency of boredom symptoms in each of the four quarters of the programmed course. Out of these four measures, only one, frequency of error frames classified as type of prompt utilized was found to be sigifincantly related to learner characteristics. The findings of this study offer useful suggestions regarding the construction and utilization of linear programmes.

Intelligence and Achievement On PLM

It is a known fact that intelligence is the major factor contributing to academic achievement. But is was believed that carefully structured sequence of an instructional material along with adequate prompting techniques and reinforcement schedules would help PLM iron out the effect of intelligence on the achievement on PLM. However, the research findings pose a conflict before a reader regrarding this aspect.

A study by Porter (1961) revealed a lower correlation between IQ and achievement in spelling for a group of subjects taught by machine than for a controlled group taught by traditional methods. Small negative correlations were found by Porter (1959) and Keislar (1959) between IQ and programme effectiveness. Glaser and Reynolds (1962) strongly emphasised in their study on the relative effectiveness of three methods that intelligence and past achievement measures may not be predictive of amount of learning resulting from linear programmed sequence.

However, other studies have tended to confirm the positive relationship between learning ability and achievement on PLM.

Silberman (1961) found that there was a definite and significant relationship between measured intelligence and amount of learning when high school students were taught logical relationships with a 400-item programme using multiple choice answers. Silberman had predicted on the basis of then current beliefs that the branching inside the programme would iron out the differences in individual learning due to intelligence, and was somewhat surprised when the differential appeared.

Hatch and Flints' study (1962) evaluated academic intelligence measures as predictors of subject matter achievement in both programmed and conventional theaching; and the study by Lambert (1962) reported that IQ is the most significant variable in immediate subject matter acquisition through programmed instruction.

Reed and Hymann (1962) reported that high-ability learners did better on programmed rather than conventional instruction, while low-ability students did better in conventional rather than programmed instruction (quite an alarming finding !). Higher retention scores on two retest intervals (2 to 30 weeks) were reported for more intelligent students than less intelligent students by Alter (1962).

Anxiety and Achievement on PLM

The instructional effectiveness of different methods varied according to differences in student personality characteristics was the finding of Traweek's study (1964). He demonstrated that students classified as exhibiting such personality traits as withdrawal, anxiety and insecurity were able to achieve at a much higher level when exposed to programmed instruction than would have been expected if they had been taught by more traditional classroom methods.

Knight and Sarsenrath (1966) administered a quasi-projective measure of achievement imagery, a test anxiety questionnaire, and an achievement pretest to 139 college undergraduates. These measures were related to three criteria: (1) time needed to complete a programmed material; (2) error rate on the programme, and (3) test of retention. The high achievement-motivated students scored better on all three criteria than low achievement-motivated students. High test anxiety students worked faster and made fewer errors than low anxiety students but failed to exhibit higher retention scores.

Bellino (1969) investigated whether there was a greater or lesser amount of learning and retention in a programmed learning situation if intrinsic and extrinsic reinforcement was a variable. The Children's Manifest Anxiety Scale was administered to 128 sixth grade students in four elementary schools. The programme was administered with subjects being assigned to reward and non-reward groups. The subjects were in one of eight groups: High Anxious Reward Boys (HARB), High Anxious No Reward Boys (HANRB), Low Anxious Reward Boys (LARB), Low Anxious No Reward Boys (LANRB), High Anxious Reward Girls (HARG), High Anxious No Reward Girls (HANRG), Low Anxious Reward Girls (LARG), Low Anxious No Reward Girls (LANRG). After being assigned to one of the groups, the subjects were given a programmed text in elementary geology. Immediately after the programme, each subject was given a post-test to measure achievement level. Two weeks later, each subject was given another post-test to measure retention. The analysis of the data using t tests supported the investigator's hypothesis in that intrinsic and extrinsic reinforcement had a facilitating effect on performance at all levels of anxiety on the programme for LARB and HARG on the achievement measure, and LARB and HARG groups on the retention measure.

Flynn and Morgan (1966) attempted to analyze the learner characteristic of anxiety in detemining the effectiveness of programmed instruction. Ninetysix sophomores from six geometry classes of a New Jersey public school were the subjects for the study. Introduction to Vector Geometry Achievement Test was administered as both a pretest and post-test measure of achievement. Test Anxiety Questionnaire, High School Form, was used to measure anxiety and Otis Quick-Scoring Mental Ability Test, Gamma Form, was administered to measure intelligence. A scrambled programme text—A Programme Introduction to Vector Geometry was used.

The experimental design followed a Treatment Levels model, the two treatments being methods of instruction and the levels being high, moderate, and low degrees of anxiety. With this design, analysis of covariance was used as the major statistical analysis of the investigation. The following conclusions were drawn :

1. The programmed instruction method of learning was not significantly superior to the control method of instruction.
2. Student achievement did not differ significantly over levels of test anxiety.
3. There was no significant interaction between method of instruction and level of test anxiety.

The one and only Indian study dealing with personality variables and performance on a programme is that of Gangopadhyaya (1971). He studied the effectiveness of two personality variables, viz., anxiety and persistence, in relation to performance on a programme. The study revealed the following : There was no significant difference between the means of high anxious group and low anxious group as also between high persistant and low persistant groups. The overall differences between the adjusted means of the four treatment groups (high anxiety-low persistence, high anxiety-high persistence, low anxiety-high persistence, low anxiety-low persistence) on criterion test of the programme were not significant at any level. The correlation between the pretest and post-test was very high. It was concluded that there is no relationship between performance on a programme and personality variables, viz., anxiety and persistence.

Intelligence, Anxiety and Achievement on PLM

O 'Reilly's (1969) study aimed at determining the importance of prior achievement (pretest), verbal IQ, anxiety and creativity to achievement from programmed materials. Theoretical considerations suggested that the structured learning conditions inherent in programmed materials may facilitate achievement for anxious learners and impede achievement for creative learners. Theory further suggested that verbal IQ and pretest would have little or no relationship to achievement when the programme is used with appropriately selected learners.

In the second phase of the study, pretest, verbal IQ, and anxiety were studied in relation to both error rate on the programme and final achievement. The intent was to determine whether the contributions of pretest, verbal IQ, and anxiety to achievement were mediated by error rate or whether these contributions were independent of error rate. 120 boys and 122 girls of sixth grade classes were included in the sample. The subjects received ten geography lessons, using a linearly constructed response programme. Before instruction, subjects received the Test Anxiety Scale for Children (TASC), Lie Scale for Children (LSC), and achievement test on the instructional content, a verbal IQ test, and four verbal creativity tests. Error rate was the number of correct responses on the programme. The achievement test was readministered when the instruction ended.

Multiple regression procedures and factorial analyses of variance showed that the beta weights for pretest and verbal IQ were significant and positive and the weight for anxiety was significant and negative. None of the creativity variables or the interactions contributed significantly to achievement.

The results of the second phase showed that only verbal IQ contributed significantly to error rate. For the final analysis on achievement, the beta weights for pretest and IQ were significant and positive; the weights for error rate and anxiety were significant and negative. Additional regression analysis tentatively indicated that IQ contributed to achievement indirectly through error rate as well as making a direct contribution to achievement. There was no indication that the significant negative contributions of pretest and anxiety were mediated by error rate.

Another study dealing with intelligence and anxiety is that of Ripple et al. (1969). The study aimed at determining the interactions between each of four personality characteristics (anxiety, compulsivity, creativity, and exhibitionism), set, intelligence and achievement (based on combined test scores of recall, transfer, and generation of hypotheses) from programmed instruction and conventional instruction. A year of extensive pilot studies, including reliability and validity checks, involved about 5000 grade eight students. The experiment, also one year in duration, involved 1100 students in grade eight classes' from 22 schools which were equated on intelligence and sex and assigned at random to either programmed or conventional instruction in vocabulary development (word meaning and usage). Pretests rated students on the four personality characteristics and intelligence. Four-way analysis of variance was performed to test all possible interactions, and the schools served as replicates in the analysis. No interactions of personality traits, sex, or intelligence with instructional mode were statistically significant.

Introversion-Extraversion and Achievement on PLM

Leith and Trown (1970) studied the influence of personality and task conditions on learning and transfer and concluded that individuals have different approaches to learning tasks. With college of education students, the teaching materials constructed so as to induce errors and to arouse ambiguity and uncertainty would favour extraverts, while carefully structured, clearly defined sequences of teaching material would give better results with introverts. At the age of 12—13 years, the differences in methods of learning can be categorised as belonging to children who are more or less introverted or extraverted.

Leith and Davis (1967) studied the influence of social reinforcement and personality on achievement in a school learning task. In this study knowledge of results and number of errors made were controlled by using a low error rate, linear self-instructional programme. Three levels of verbal incentives—positive, neutral and negative, were administered in standard form to thirty children of 13 years in each of four schools. Two of these were situated in a slum environment and two had a good environment. In one school, from each type of environment two incentives per lesson were given in the programme. The other two schools had reinforcement in the form of a standard teacher comment given individually at the beginning of the next lesson. Overall, positive was better than neutral and this than negative reinforcement. There was no significant interaction between personality type and type of reinforcement but anxious introverts were significantly the best group.

Personality and Achievement by Linear and Branching Programmes

Friedman (1966) studied the effect of personality and interest variables on learning by linear and scrambled methods of programmed instruction. The experiment involved 157 students from two schools. The students in each school were divided into two groups and given two methods of programmed instruction. Group A, consisting of 79 students, was given a linear programme. Group B, consisting of 78 students, was given a scrambled programme. Both the groups were given three personality measures, the MMPI, the ICL and the TAT, and two interest measures, the Semantic Differential and the Student Log Check List. Pre-and post-achievement tests were also administered. The data were analyzed by factor analysis and Pearson product moment correlation.

The following were the results obtained from factor analyses :

1. No relationship was noted between multilevel submissive personality variables to achievment by the linear method.
2. Only a bilevel relationship between the submissive personality variables and achievement by the scrambled method of programmed instruction was noted.

The results obtained from the Pearson product moment analysis were as follows :

1. A significant relationship was noted between achievement by the scrambled method of programmed instruction and personality variables on various levels. Variability between levels favoured achievement by the scrambled method.
2. A significant relationship was noted between achievement and the linear method for various levels.
3. A positive relationship was found between interest in subject matter, interest in programme and achievement by scrambled and linear methods.

Filep (1967) examined the relationship of learner characteristics of IQ, achievement, sex, ethnic classification, parents' occupational grouping and audio-visual stimuli presented in linear and branching sequences.

The experimental population consisted of 1,222 eighth grade students drawn from four junior high schools.

The findings were as follows :

1. The learner characteristics did interact with media and programming modes to affect scores on the dependent variable. Total IQ scores provided the highest correlation with the dependent variable.
2. Exceptional children, identified as having low IQ, non-white, and representing the three lowest occupational groups, obtained higher scores after receiving the non-verbal, sound, branching treatments provided in this study.
3. Some indications were obtained that children in the exceptional category perform better on all branching treatments.

4. The results of comparisons of the linear and branchnig modes revealed different patterns for all three experiments (using subject content designated as non-concrete concrete and action-process). In all three the scores for students completing the branching treatments were higher. An analysis of covariance indicated that this was significant, ($p < .10$) in experiment I, ($p < .05$) in experiment II, and N S D in experiment III.

Beane (1962) compared linear and branching technique of programmed instruction. Sixtyfive students in two classes in high school geometry were assigned by stratified random procedure, on the basis of the Hennon-Nelson Test of Mental Ability, to form experimental groups Two groups used a linear or a branching type programme exclusively, and two switched programme type midway through the experiment. The controlled group was given conventional instruction. Both programmes were constructed from the text normally used by the class. An achievement test was administered as pretest, post-test and seven week delayed retention test. An attitude questionnaire was given half way through the experiment, with the post-test, and with the retention test. Analysis of variance showed no significant differences among experimental groups in achievement or retention, although a subgroup of high ability performed significantly better than one of low ability students in all conditions. Although all experimental groups preferred programmed to conventional instruction during and immediately after the experiment, no preference was shown seven weeks later. The linear programme was preferred to the branching programme by the entire group, although it took significantly longer to complete than the branching programme.

The above review of research indicates clearly that there are many unanswered questions regarding programmed learning and individual differences in learner characteristics. The fact that the findings related to the relationship between intelligence and achievement on PLM and anxiety and achievement on PLM are contradictory, indicates that the area of individual differences has remained almost neglected and more extensive research in this area is needed before coming to any conclusions.

HYPOTHESES

After realising the need for an investigation, the future results are assumed on the basis of the work being done so far in the field. Following are the basic assumptions underlying the present investigation which are arrived at from the past researches, related literature and general knowledge about the learners.

Statistically, the null haypothesis was accepted for the present investigation. To be more specific, it was hypothesised that :

1. There is no significant relationship between intelligence and achievement on PLM — both linear and branching.
2. There is no significant relationship between anxiety and achievement on PLM — both linear and branching.
3. There is no significant relationship between introversion-extraversion and achievement on PLM — both linear and branching.
4. There is no significant relationship between self-sufficiency and achievement on PLM—both linear and branching.

OBJECTIVES

The purpose of this investigation was to see whether or not the personality variables were significantly related to the achievement on PLM. This broad objective was further delineated into more specific objectives as follows :

1. To study the relationship between the immediate achievement on linear and branching programmes and some selected personality variables.
2. To study the relationship between the retention scores on linear and branching programmes and some selected personality variables.

TERMS DEFINED

The terms used in this investigation connote the following :

Personality Variables Variable means any trait that changes from one case or conditon to another. Here the term personality variables implies personality traits.

Programmed Learning Material (PLM) It is an instructional material which helps in structuring an efficient and effective learning situation.

Achievement of Pupils on PLM Achievement of pupils on PLM is judged in terms of the scores obtained on the criterion test of the programme—given immediately after completing the programme and after an interval of a few weeks after completing the programme.

SCOPE OF THE STUDY

Before generalising the findings of the present investigation, it is necessary to keep in mind some of its limitations.PLM can be presented in different forms and can be used for many subjects. The conclusions drawn hereafter would not be generalisable for all the forms, for all the subjects and for all the situations. In other words, the scope of the present investigation is limited so for as the following points are concerned :

1. The effectiveness of PLM, in this investigation, is judged by the achievement of pupils on the criterion tests of one linear programme in science and one branching programme in geography.
2. The pupils included in this investigation were from the Gujarati medium secondary schools of the city of Baroda.
3. The pupils selected for the investigation were from Std. VIII (as the topic of the programmes was already covered in Std. IX).
4. The personality variables studied for the present investigation were four, viz., intelligence, anxiety, self-sufficiency and introversion-extraversion.

PROCEDURE

Tools Used

The tools used for collecting the data were as follows :

1. A linear programme on heart and blood circulation.
2. A branching programme on factors affecting air pressure.
3. Desai and Bhatt Verbal Group Test of Intelligence.
4. Bernreuters' Personality Inventory.
5. IPAT Anxiety Scale by R. B. Cattell.
6. A criterion test of the linear programme.
7. A criterion test of the branching programme.

Results

Partial correlation was applied to analyse the data. Given below is an 8 × 8 correlation matrin.

Sample

As many as 11 schools of Baroda city were randomly selected, and all the pupils of Std. VIII were included in the sample. Excluding the wastage on account of absence from the school or incomplete work, the final sample came down to 525 pupils—299 girls and 226 boys.

Collection of Data

All the tools mentioned above were administered to the pupils. Each batch on an average took three days to complete the programmes, tests and inventories.

The criterion tests of the programmes were given immediately after completion of the programmes. The same tests were administered to the same pupils after an interval of two months in order to measure their retention. Thus two types of scores were obtained from the same tests—immediate score and retention score.

The tests and inventories were scored and the raw scores of personality variables viz. anxiety, selfsufficiency and introversion-extraversion were converted into standard scores. A correlation matrix was prepared for the 8 variables and finally, partial correlations were calculated for each personality variable, and immediate and retention scores on both the programmes.

Table 1 : Correlation Matrix

1.	1.000							
2.	−.27753	1.000						
3.	−.8040	−.23035	1.000					
4.	−.16666	.32575	−.48756	1.000				
5.	.56752	−.32308	.05668	−.19779	1.000			
6.	.51305	−.24674	.07466	−.19569	.67784	1.000		
7.	.34098	−.17044	.05238	−.13606	.35749	.38621	1.000	
8.	.38010	−.18962	.11793	−.15278	.34156	.42205	.48339	1.000
	1	2	3	4	5	6	7	8

In the above matrix and in the formulae and tables to follow, the numerals 1 to 8 indicate the following variables :

Intelligence.........1
Anxiety.........2
Self-sufficiency........3
Introversion-extraversion......4
Linear programme—immediate scores......5
Linear programme—retention scores......6
Branching programme—immediate scores......7
Branching programme—retention scores......8

Observations

The zero order correlations as mentioned in the correlation matrix indicate the following :

1. There is a positive correlation between intelligence and achievement* on linear as well as branching programmes.
2. The correlations between intelligence and achievement on the linear programme are higher than those between intelligence and achievement on the branching programme.
3. The correlations between intelligence and achievement on the linear programme as well as between intelligence and achievement on the branching programme, are significant at .01 level of confidence.
4. Anxiety is negatively correlated with achievement on the linear as well as branching programmes.
5. The correlations between anxiety and achievement on the linear as well as branching programmes are significant at .01 level.

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* the term 'achievement' here includes both immediate and retention scores.

6. The correlations between self-sufficiency and achievement on the linear as well as branching programmes are positive, but very low.

7. The correlations between self-sufficiency and achievement on the linear programme and immediate scores on the branching programme are not significant.

8. The correlation between self-sufficiency and retention scores on the branching programme is significant at .01 level of confidence.

9. The correlation between introversion-extraversion and achievement on the linear and branching programmes are negative.

10. The correlations between introversion-extraversion and achievement on the linear and branching programmes are significant at .01 level of confidence.

11. In general, the correlations between personality variables and immediate scores on the linear programme are higher than those between personality variables and retention scores on the same programme. In case of self-sufficiency, it is just the reverse.

12. In general, the correlations between personality variables and immediate scores on the branching programme are lower than those between personality variables and retention scores on the branching programme.

Partial correlations between each of the personality variables and each of the dependent variables were computed using the following formulae :-

The formula for the partial correlation of the third order :

$$r_{15.234} = \frac{r_{15.23} - r_{14.23}\, r_{54.23}}{\sqrt{1 - r^2_{14.23}}\sqrt{1 - r^2_{54.23}}}$$

The numerals used here indicate the same variables as mentioned before. Hence, this formula gives the correlation between variable 1 and 5, viz., intelligence and immediate score on the linear programme when variables 2, 3, 4, viz., anxiety, self-sufficiency and introversion-extraversion, are partialled out. The formula used for the partial correlations of the second order was as follows :

$$r_{15.23} = \frac{r_{15.2} - r_{13.2}\, r_{53.2}}{\sqrt{1 - r^2_{13.2}}\sqrt{1 - r^2_{53.2}}}$$

This formula gives the correlation between intelligence and immediate scores on the linear programme when anxiety and self-sufficiency are partialled out.

The formula used for the partial correlations of the first order was as follows :

$$r_{15.2} = \frac{r_{15} - r_{12}\, r_{52}}{\sqrt{1 - r^2_{12}}\sqrt{1 - r^2_{52}}}$$

$$r_{13.2} = \frac{r_{13} - r_{12}\, r_{32}}{\sqrt{1 - r^2_{12}}\sqrt{1 - r^2_{32}}}$$

$$r_{53.2} = \frac{r_{53} - r_{52}\, r_{32}}{\sqrt{1 - r^2_{52}}\sqrt{1 - r^2_{32}}}$$

These formulae give the correlations between intelligence and immediate scores on the linear programme, intelligence and self-sufficiency and self-sufficiency and immediate scores on linear programme when anxiety is partialled out. Thus the correlations of zero order will lead to the correlations of the first order, which in turn will lead to the correlations of the second order which in turn will be useful for calculating the correlations of the third order.

Table 2 : Partial Correlations Between Intelligence and Immediate Scores Using the Linear Programme

Partial r's of the First Order	$r_{15.2} = .53$	$r_{4.2} = -.08$	$r_{54.2} = .11$
	$r_{13.2} = .02$	$r_{13.2} = .02$	$r_{53.2} = -.02$
	$r_{53.2} = -.02$	$r_{43.2} = -.45$	$r_{43.2} = -.45$
Partial r's of the Second Order	$r_{15.23} = .54$	$r_{4.23} = -.7$	$r_{54.23} = -.11$
Partial r's of the Third Order	$r_{15.234} = +.54$		

$$\text{Fisher's } z = .60$$
$$SE_z = .043$$

The .95 confidence interval for population z is .60 ± 1.96 × .043 or between .52 and .68. when these z's are converted back into r's, we have a .95 confidence interval of .48 to .59.

Observations

(1) It can be seen that correlation between intelligence and immediate achievement on the linear programme in Science, after partialling out anxiety, self-sufficiency and introversion-extraversion, is positive.

(2) The fiduciary probability is .95, that z lies between. .52 and .68, and r lies between .48 and .59. Hence $r_{15.234}$ = .54 is significant in the sense that the population r is not likely to be zero (the lower limit of the confidence range is .48).

Table 3 : Partial Correlation Between Anxiety and Immediate Scores Using the Linear Programme

Partial r's	$r_{25.1} = -.20$	$r_{24.1} = .30$	$r_{54.1} = -.13$
of the	$r_{23.1} = -.22$	$r_{23.1} = -.22$	$r_{53.1} = .02$
First Order	$r_{53.1} = .18$	$r_{43.1} = -.49$	$r_{43.1} = -.49$
Partial r's of the Second Order	$r_{25.23} = .21$	$r_{24.13} = .23$	$r_{54.13} = -.14$
Partial r's of the Third Order	$r_{25.134} = -.18$		

Fisher's z = −.18

SE_z = .043

The .95 confidence interval for population z is −.1835 ± 1.96 × .043 or between −.10 and −.27. When these z's are converted back into r's, we have a .95 confidence interval of −.10 to−.27.

Observations

(1) It can be seen that the correlations between anxiety and immediate achievement on the linear programme in Science, after partialling out intelligence, self-sufficiency and introversion-extraversion, is negative.

(2) The fiduciary probability is .95, that z lies between −.10 and −.27 and r lies between −.10 and −.27. Hence

$r_{25.134} = -.18$ is significant in the sense that the population r is not likely to be zero (the lower limit of the confidence range is -.10).

Table 4 Partial Correlations Between Self-Sufficiency and Immediate Scores Using the Linear Programme.

Partial r's of the First Order	$r_{35.1} = -.02$ $r_{32.1} = -.22$ $r_{52.1} = -.20$	$r_{34.1} = -.49$ $r_{32.1} = -.22$ $r_{42.1} = .30$	$r_{54.1} = -.13$ $r_{52.1} = -.20$ $r_{42.1} = .30$
Partial r's of the Second Order	$r_{35.12} = -.27$	$r_{34.12} = -.46$	$r_{54.12} = -.07$
Partial r's of the Third Order	$r_{35.124} = -.07$		

$$\text{Fisher's } z = -.07$$
$$SE_z = .043.$$

The .95 confidence interval for population z is -.06939 ± 1.96 × .043 or between -.15 and +.01. When these z's are converted back into r's, we have a .95 confidence interval of -.15 to + .01.

Observations

(1) It can be seen that the correlation between self-sufficiency and immediate achivement on the linear programme in science after partialling out intelligence, anxiety and introversion–extraversion, is negative.

(2) The fiduciary probability is .95, that z lies between -.15 to +.01 and r lies between -.15 to +.01. Hence $r_{35.124} = -.07$, is not significant.

Table 5 : Partial Correlations Between Introversion-Extraversion and Immediate Scores Using the Linear Progrgmme.

Partial r's of the First Order	$r_{42.1} = .30$	$r_{43.1} = -.49$	$r_{53.1} = .02$
	$r_{45.1} = -.13$	$r_{42.1} = .30$	$r_{52.1} = -.20$
	$r_{52.1} = -.20$	$r_{32.1} = -.22$	$r_{32.1} = -.22$
Partial r's of the Second Order	$r_{45.12} = -.07$	$r_{43.12} = -.46$	$r_{53.12} = -.03$
Partial r's of the Third Order	$r_{45.123} = -.06$		

$$\text{Fisher's } z = -.06$$
$$SE_z = .043$$

The .95 confidence interval for population z is -.06054 ± 1.96 × .043 or between -.14 and +.02. When these z's are converted back into r's, we have a .95 confidence interval of -.14 to +.02.

Observations

(1) It can be seen that the correlation between introversion-extraversion and immediate achievement on the linear programme in Science after partialling out intelligence, anxiety and self-sufficiency, is positive.

(2) The fiduciary probability is .95, that z lies between -.15 and +.02. Hence $r_{45.23} = -.06$, is not significant.

Table 6 : Partial Correlations Between Intelligence and Retention Scores Using the Linear Programme

Partial r's of the First Order	$r_{16.2} = .47$ $r_{13.2} = .02$ $r_{63.2} = .12$	$r_{14.2} = -.08$ $r_{13.2} = .02$ $r_{43.2} = -.45$	$r_{64.2} = -.13$ $r_{63.2} = .12$ $r_{43.2} = -.45$
Partial r's of the Second Order	$r_{16.23} = .47$	$r_{14.23} = -.07$	$r_{64.23} = -.09$
Partial r's of the Third Order	$r_{16.234} = .48$		

$$\text{Fisher's } z = .52$$
$$SE_z = .043$$

The .95 confidence interval for population z is .52 ± 1.96 × .043 or between .44 to .60. When thses z's are converted back into r's, we have a .95 confidence interval of .41 to .54.

Observations

(1) It can be seen that the correlation between intelligence and retention scores on the linear programme in Science, after partialling out anxiety, self-sufficiency and introversion-extraversion, is positive.

(2) The fiduciary probability is .95, that z lies between .44 and .60, and r lies between .41 and .54. Hence $r_{16.234} = .48$, is significant in the sense that the population r is not likely to be zero (the lower limit of the confidence range is .41).

Table 7 : Partial Correlations Between Anxiety and Retention Scores Using the Linear Programme

Partial r's of the First Order	$r_{26.1} = -.13$	$r_{24.1} = .30$	$r_{64.1} = -.13$
	$r_{23.1} = -.22$	$r_{23.1} = -.22$	$r_{63.1} = .04$
	$r_{63.1} = .04$	$r_{43.1} = -.49$	$r_{43.1} = -.49$
Partial r's of the Second Order	$r_{26.13} = -.12$	$r_{24.13} = .23$	$r_{64.13} = -.13$
Partial r's of the Third Order	$r_{26.134} = -.13$		

$$\text{Fisher's } z = -.13$$
$$SE_z = .043$$

The .95 confidence interval for population z is −.128 ± 1.96 × .043 or between −.04 to −.21. When these z's are converted back into r's, are have a .95 confidence interval of −.04 to −.21.

Observations

(1) It can be seen that the correlation between anxiety and retention scores on the linear programme in Science, after partialling out intelligence, self-sufficiency and introversion-extraversion, is negative.

(2) The fiduciary probability is .95, that z lies between −.04 and −.21, and r lies between −.04 and −.21. Hence $r_{26.134} = -.13$, is significant in the sense that the population r is not likely to be zero (the lower limit of the confidence range is −.04).

Table 8 : Partial Correlations Between Self-Sufficiency and Retention Scores Using the Linear Programme.

Partial r's of the First Order	$r_{36.1} = .04$ $r_{32.1} = -.22$ $r_{62.1} = -.13$	$r_{34.1} = -.49$ $r_{32.1} = -.22$ $r_{42.1} = .30$	$r_{64.1} = -.13$ $r_{62.1} = -.13$ $r_{42.1} = -.30$
Partial r's of the Second Order	$r_{36.12} = .01$	$r_{34.12} = -.46$	$r_{64.12} = -.11$
Partial r's of the Third Order	$r_{36.124} = -.042$		

Fisher's $z = -.042$

$SE_z = .043$

The .95 confidence interval for population z Is $-.0417 \pm 1.96 \times .043$ or between $-.13$ to $+ .04$. When the z's are converted back into r's, we have a .95 confidence interval of $-.13$ to $+ .04$.

Observations

(1) It can be seen that the correlation between self-sufficiency and retention scores on the linear programme in Science after partialling out intelligence, anxiety and introversion-extraversion, is negative.

(2) The fiduciary probability is .95, that z lies between $-.13$ and $+.04$ and r lies between $-.13$ and $+.04$. Hence $r_{36.124} = -.042$, is not significant.

Table 9 : Partial Correlations Between Introversion–Extraversion and Retention Scores Using the Linear Programme

Partial r's of the First Order	$r_{46.1} = -.13$	$r_{43.1} = -.49$	$r_{63.1} = .04$
	$r_{42.1} = .30$	$r_{42.1} = .30$	$r_{62.1} = -.13$
	$r_{62.12} = -.13$	$r_{32.1} = -.22$	$r_{32.1} = -.22$
Partial r's of the Second Order	$r_{46.12} = -.10$	$r_{43.12} = -.46$	$r_{63.12} = .01$
Partial r's of the Third Order	$r_{46.123} = -.05$		

Fisher's $z = .05$
$SE_z = .043$

The .95 confidence interval for population z is $-.05053 \pm 1.96 \times .043$ or between −.13 to + .03. When these z's are converted back into r's, we have a .95 confidence interval of −.13 to + .03.

Observations

(1) It can be seen that the correlation between introversion–extraversion and retention scores on the linear programme in Science after partialling out intelligence, anxiety and self–sufficiency, is negative.

(2) The fiduciary probability is .95, that z lies between −.13 and + .03, and r lies between −.13 and + .03. Hence $r_{46.123} = -.05$, is not significant.

Table 10 : Partial Correlations Between Intelligence and Immediate Scores Using the Branching Programme

Partial r's of the First Order	$r_{17.2} = .35$	$r_{14.2} = -.08$	$r_{74.2} = -.09$
	$r_{13.2} = .02$	$r_{13.2} = .02$	$r_{73.2} = .01$
	$r_{13.2} = .01$	$r_{43.2} = -.45$	$r_{43.2} = -.45$
Partial r's of the Second Order	$r_{17.23} = .36$	$r_{14.23} = -.07$	$r_{74.23} = -.08$
Partial r's of the Third Order	$r_{17.234} = .36$		

$$\text{Fisher's } z = .38$$
$$SE_z = .043$$

The .95 confidence interval for population z is $.38 \pm 1.96 \times .043$ or between .30 to .46. When these z's are conveted back into r's we have a .95 confidence interval of .29 to .43.

Observations

(1) It can be seen that the correlation between intelligence and immediate achievement on the branching programme in Geography after partialling out anxiety, self-sufficiency and introversion-extraversion, is positive.

(2) The fiduciary probility is .95, that z lies between .30 and .46, and r lies between .28 and .43. Hence $r_{17.234} = .36$ is significant in the sense that the population r is not likely to be zero (the lower limit of the confidence range is .29).

Table 11 : Partial Correlations Between Anxiety and Immediate Scores Using the Branching Programme

Partial r's of the First Order	$r_{27.1} = -.09$ $r_{23.1} = -.22$ $r_{73.1} = -.03$	$r_{24.1} = -.30$ $r_{23.1} = -.22$ $r_{43.1} = -.49$	$r_{74.1} = -.09$ $r_{73.1} = -.03$ $r_{43.1} = -.49$
Partial r's of the Second Order	$r_{27.13} = -.08$	$r_{24.13} = .23$	$r_{74.13} = -.08$
Partial r's of the Third order	$r_{27.134} = -.07$		

Fisher's $z = -.07$

$SE_z = .043$

The .95 confidence interval for population z is –.06575 ± 1.96 × .043 or between –.15 to + .02. When these z's are converted back into r's, we have a .95 confidence interval of –.15 to + .02.

Observations

(1) It can be seen that the correlation between anxiety and immediate achievement on the branching programme In Geography after partialling out intelligence, self-sufficiency and introversion-extraversion, is negative.

(2) The fiduciary probability is .95, that z lies between –.15 and + .02, and r lies between –.15 and + .02. Hence $r_{27.134} = -.07$, is not significant.

Table 12 : Partial Correlations Between Self-Sufficiency and Immediate Scores Using the Branching Programme

Partial r's of the First Order	$r_{37.1}$ = .03 $r_{32.1}$ = −.22 $r_{37.1}$ = −.09	$r_{34.1}$ = −.49 $r_{32.1}$ = −.22 $r_{42.1}$ = .30	$r_{74.1}$ = −.09 $r_{72.1}$ = −.09 $r_{42.1}$ = .30
Partial r's of the Second Order	$r_{37.12}$ = .01	$r_{34.12}$ = −.46	$r_{74.12}$ = −.06
Partial r's of the Third Order	$r_{37.124}$ =− .02		

Fisher's z = −.02
SE_z = .043

The .95 confidence interval for population z is −.02412 ± 1.96 × .043 or between −.11 to + .06. When these z's are converted back into r's, we have a .95 confidence interval of −.11 to + .06.

Observations

(1) It can be seen that the correlation between self-sufficiency and immediate achievement on the branching programme in Geography after partialling out intelligence, anxiety and introversion-extraversion, is negative.

(2) The fiduciary probability is .95, that z lies between −.11 and + .06 and r lies between −.11 and + .06. Hence $r_{37.124}$ = −.02, is not significant.

Table 13 : Partial Correlations Between Introversion–Extraversion and Immediate Scores Using the Branching Programme

Partial r's of the First Order	$r_{47.1} = -.09$	$r_{43.1} = -.49$	$r_{73.1} = .03$
	$r_{72.1} = -.09$	$r_{42.1} = .30$	$r_{72.1} = -.09$
	$r_{42.1} = .30$	$r_{32.1} = -.22$	$r_{32.1} = -.22$
Partial r's of the Second Order	$r_{47.12} = -.06$	$r_{43.12} = -.46$	$r_{73.12} = .01$
Partial r's of the Third Order	$r_{47.123} = -.07$		

$$\text{Fisher's } z = -.07$$
$$SE_z = .043$$

The .95 confidence interval for population z is –.06911 ± 1.96 × .043 or between –.15 to +.02. When these z's are converted back into r's we have a .95 confidence interval of –.15 to +.02.

Observations

(1) It can be seen that the correlation between introversion–extraversion and immediate achievement on the branching programme in Geography after partialling out intelligence, anxiety and self-sufficiency, is negative.

(2) The fiduciary probability is .95, that z lies between –.15 and +.02, and r lies between –.15 and +.02. Hence, $r_{47.123} = -.07$ is not significant.

Table 14 : Partial Correlations Between Intelligence and Retention Scores Using the Branching Programme

Partial r's of the First Order	$r_{18.2} = .35$	$r_{14.2} = -.08$	$r_{84.2} = -.10$
	$r_{13.2} = .02$	$r_{13.2} = .02$	$r_{83.2} = .08$
	$r_{83.2} = .08$	$r_{43.2} = -.45$	$r_{43.2} = -.45$
Partial r's of the Second Order	$r_{18.23} = .35$	$r_{14.23} = -.07$	$r_{84.23} = .12$
Partial r's of the Third Order	$r_{18.234} = .35$		

Fisher's z = .37

SE_z = .043

The .95 confidence interval for population z is .37 ± 1.96 × .043 or between .29 to .45. When these z's are converted back into r's, we have a .95 confidence interval of .27 to .42.

Observations

(1) It can be seen that the correlation between intelligence and retention scores on the branching programme in Geography after partialling out anxiety, self-sufficiency and introversion-extraversion, is positive.

(2) The fiduciary probability is .95, that z lies between .29 and .45, and r lies between .27 and .42. Hence $r_{18.234} = .35$ is significant in the sense that the population r is not likely to be zero (the lower limit of the confidence range is .27).

Table 15 : Partial Correlations Between Anxiety and Retention Scores Using the Branching Programme

Partial r's of the First Order	$r_{28.1} = -.10$	$r_{24.1} = .30$	$r_{84.1} = -.10$
	$r_{23.1} = -.22$	$r_{23.1} = -.22$	$r_{83.1} = .10$
	$r_{83.1} = .10$	$r_{43.1} = -.49$	$r_{43.1} = -.49$
Partial r's of the Second Order	$r_{28.13} = -.08$	$r_{24.13} = .23$	$r_{84.13} = -.06$
Partial r's of the Third Order	$r_{28.134} = -.07$		

Fisher's $z = .07$
$SE_z = .043$

The .95 confidence interval for population z is −.06702 ± 1.96 × .043 or between −.15 to + .02 When these z's are converted back into r's, we have a .95 confidence intervel of −.15 to + .02.

Observations

(1) It can be seen that the correlation between anxiety and retention scores on the branching programme in Geography after partialling intelligence, self-sufficiency and introversion-extraversion, is negative.

(2) The fiduciary probability is .95, that z lies between −.15 and + .02 and r lies between −.15 and + .02. Hence $r_{28.134} = -.07$, is not significant.

Table 16 : Partial Correlation Between Self-Sufficiency and Retention Scores Using the Branching Programme

Partial r's of the First Order	$r_{38.1} = .10$ $r_{32.1} = -.22$ $r_{82.1} = -.10$	$r_{34.1} = -.49$ $r_{32.1} = -.22$ $r_{42.1} = .30$	$r_{84.1} = -.10$ $r_{82.1} = -.10$ $r_{42.1} = +.30$
Partial r's of the Second Order	$r_{38.12} = +.08$	$r_{34.12} = -.46$	$r_{84.12} = -.08$
Partial r's of the Third Order	$r_{38.124} = .05$		

Fisher's $z = .05$

$SE_z = .043$

The .95 cofidence interval for population z Is +.05393 ± 1.96 × .043 or between −.03 to + .14. When these z's are converted back into r's, we have a .95 confidence interval of −.03 to + .14.

Observations

(1) It can be seen that the correlation between self-sufficiency and retention scores on the branching programme in Geography after partialling intelligence, anxiety and introversion-extraversion, is positive.

(2) The fiduciary probability is .95, that z lies between −.03 and +.14, and r lies between −.03 and +.14. Hence $r_{38.124} = .05$, is not significant.

Table 17 : Partial Correlations Between Introversion–Extraversion and Retention Scores Using the Branching Programme

Partial r's of the First Order	$r_{48.1} = -.10$	$r_{43.1} = -.49$	$r_{83.1} = .10$
	$r_{42.1} = +.30$	$r_{42.1} = .30$	$r_{32.1} = -.22$
	$r_{82.1} = -.10$	$r_{32.1} = -.22$	$r_{82.1} = -.10$
Partial r's of the Second Order	$r_{48.12} = -.08$	$r_{43.12} = -.46$	$r_{83.12} = .08$
Partial r's of the Third Order	$r_{48.123} = -.04$		

Fisher's $z = -.04$

$SE_z = .043$

The .95 confidence interval for population z is −.04294 ± 1.96 × .043 or between −.13 to +.04. When these z's are converted back into r's, we have a .95 confidence interval of −.13 to + .04.

Observations

(1) It can be seen that the correlation between introverion–extraversion and retention scores on the branching programme after partialling intelligence, anxiety, and self-sufficiency, is negative.

(2) The fiduciary probability is .95, that z lies between −.13 and +.04 and r lies between −.13 and + .04. Hence $r_{48.123} = -.04$, is not significant.

In the pages to follow, the results of partial correlations between the selected personality variables and the immediate and retention scores of linear and branching programmes are given and discussed in view of the related studies and the hypotheses formulated.

Table 18 : Partial Correlations Showing the Inter-relationship Between Programme Types and Intelligence

Programme Type	r between intelligence & immediate score	Significance	r between intelligence & retention score	Significance
Linear	0.54	Significant at .05 level	0.48	Significant at .05 level
Branching	0.36	Significant at .05 level	0-35	Significant at .05 level

RESULTS AND DISCUSSION

Intelligence and Achievement on PLMs :

1. There is significant and positive relationship between the achievement on both the types of PLM and intelligence. The null hypothesis that population r between intelligence and achievement on PLM is zero could, therefore be rejected.

The studies which support the positive and significant correlation between intelligence and achievement on PLM are those of Woodruff, Faltz, Wagner (1966), Hatch and Flint (1962), Lambert (1962), Reed and Hymann (1962), Shay (1961), Eigen and Feldhusen (1964).

The study by Silberman (1961) supports the significant positive relationship between intelligence and amount of learning when students were taught with a programme using multiple choice answers (branching programme).

The study conducted by Alter (1962) supports the significant and positive relationship between intelligence and retention scores on PLM.

The studies which show results contradictory to the results of the present investigation are those of Porter (1961), Porter (1959), Keisler (1959), Glaser and Reynolds (1962), Jensen (1963). These studies show low and sometimes negative correlations between intelligence and achievement on PLM.

2. The corelations between intelligence and achievement on the linear programme are higher than those between intelligence and achievement on the branching programme. The significant correlations between intelligence and achievement on PLMs are in conformity with the basic assumption that programmed learning materials being carefully structured, cater to the individual needs of the pupils—in terms of their intellectual ability. Intelligence, according to the general belief of the advocates of programmed learning, does not correlate significantly either with the immediate scores or with the retention scores. The results of the present investigation rule out this belief as the correlations between intelligence and achievement on PLMs are significant. But the magnitude of correlations between intelligence and retention scores is slightly lower than that between intelligence and immediate scores.

3. The correlations between immediate scores on linear and branching programmes are higher than the correlations between retention scores on linear and branching programmes. This may be due to certain factors like interest in the subject, attitude towards the subject, experiences with the learning material etc. which operate during the period between the immediate testing and delayed testing and hence may affect retention.

Inferences

1. The results indicate that, with time lapse, intelligence appears to have less influence over achievement on both the types of programmes.

2. As the correlation between intelligence and

achievement on the branching programme is lower than that between intelligence and achievement on the linear programme, it is possible to minimise the individual differences on intellectual ability by using branching programmes.

Table 19 : Partial Correlations Showing the Interrelationship Between Programme Types and Anxiety

Programme type	r between anxiety and immediate score	Significance	r between anxiety and retention score	Significance
Linear	-0.18	Significant at .05 level	-0.13	Significant at .05 level
Branching	-0.07	Not significant	-0.07	Not Significant

RESULTS AND DISCUSSION

Anxiety and Achievement on PLMs :

1. There is negative and significant relationship between anxiety and achievement on the linear programme. The null hypothesis that population r between anxiety and achievement on PLM is zero could, therefore, be rejected as far as the linear programme is concerned.

The studies which support this finding are those by Flynn and Morgan (1966), Gangopadhyaya (1971), McCandless and Castaneda (1956), Feldhusen and Klausmeier (1962), Flanders (1951), McKeachie et al.(1955), Sarason et al.(1960a), Sarason (1960b), Costello (1964) and O'Reilly (1969).

However, the studies by Traweek (1964), Knight and Sarsenrath (1966), Bellino (1969), and Ripple (1969) reveal that anxious students achieved more when taught through PLM. Bellino's study (1969) showed the significant relationship between anxiety and retention scores. These studies do not support the finding of the present investigation.

2. Anxiety is significantly related to achievement on the linear programme.

3. The correlations between anxiety and the achievement on the branching programme are not significant.

Inferences

1. Within the limitations of the present inquiry it appears that anxious children tend to achieve less on programmed learning material.
2. Anixety does not seem to influence achievement on the branching programme. The explanation given for selecting the wrong answers, as it is given in the branching programme, seems to have a facilitating effect on achievement of the anxious pupils.
3. As anxiety is not significantly related to achievement on the branching programme, the effect of anxiety can be ironed out by giving branching programmes.
4. Anxious children are likely to retain less when they learn by a linear programme but anxiety does not seem to affect retention if the subject matter is learnt by a branching programme.

Table 20 : Partial Correlations Showing the Interrelationship Between Programme Types and Self-Sufficiency

Programme type	r between self-sufficiency and immediate score	Significance	r between self-sufficiency and retention score	Significance
Linear	-0.07	Not Significant	-0.042	Not significant
Branching	-0.02	Not significant	+0.05	Not significant

RESULTS AND DISCUSSION

Self-Sufficiency and Achievement on PLMS :

1. There is no significant relationship between self-sufficiency and immediate and retention scores on the linear programme.

2. There is no significant relationship between self-sufficiency and immediate and retention scores on branching programme. The null hypothesis that population r between anxiety and achievement on PLM is zero could, therefore, be retained.

Inferences

1. The achievement on both types of programme is not influenced by self-sufficiency as it is evident by non-significant correlations. It appears from this result that the characteristics such as being independent, resolute, going one's own way, making one's own decisions etc. do not have any relation with learning the programmed way.
2. The probable reason for non-significant correlations between self-sufficiency and achievement on

PLMs can be that the present educational system provides little opportunity for the pupils to be self-sufficient as the learning situation is tightly structured and the methods are outdated. As a result, few pupils show the qualities which would make them self-sufficient.

Table : 21 Partial Correlation Showing the Interrelationship Between Programme Types and Introversion - Extraversion.

Programme type	r between I – E and immediate score	Significance	r between I – E and retention score	Significance
Linear	– 0.06	Not significant	– 0.05	Not significant
Branching	– 0.07	Not significant	– 0.04	Not significant

RESULTS AND DISCUSSION

Introversion-Extraversion and Achievement on PLMs :

1. There is no significant relationship between introversion–extraversion and immediate and retention scores on the linear programme.

2. There is no significant relationship between introversion–extraversion and immediate and retention scores on branching programme. The null hypothesis that population r between introversion–extraversion and achievement on PLM is zero could, therefore, be retained.

Not a single study from those reviewed by the investigator supports the findings. The studies by Leith and Trown (1970), Leith and Davis (1967), Leith (1968a), Leith and Bossett (1967), and Leith and Wisdom (1969) show that introverts learn better when the learning task is well-structured and highly prompted.

Inferences

1. Introversion-extraversion does not come in the way of pupils' achievement on either linear or branching programmes. The theoretical considerations suggest that a pupil who shows inhibitory emotional expression and withdraws from social contacts would find it easier to learn by programmed learning material as it does not require him to face the teacher or his peer group. However, the findings of the present investigation are in contrast with the theoretical considerations and the findings of previous studies. It is assumed that introverts would be at an advantage where learning situation does not require them to interact with other people. But at the same time, extraverts are not at a disadvantage in such a situation because when they can interact with people without any inhibitions there won't be any difficulty for them to interact with the learning meterials such as programmed learning materials. This may explain why the present investigation does not show any relationship between introversion-extraversion and achievement on PLMs.

2. Being an introvert or extravert does not help in retention of the subject matter learnt previously by programmed learning material.

A comprehensive table giving the total image of the results of the investigation is given below. The observations follow the table.

Table 22 : Partial Correlations Showing the Interrelationship Between All Personality Variables and Immediate Scores and Retention Scores on Linear and Branching Programmes

Personality variables	Linear Programme immediate score	Linear Programme retention score	Branching Programme immeiate score	Branching Programme retention score
Intelligence	.54	.48	.36	.35
Anxiety	–.18	–.13	–.07	–.07
Self-sufficiency	–.07	–.04	–.02	.05
Introversion-extraversion	–.06	–.05	–.07	–.04

OBSERVATIONS

(i) There is little relationship between personality variables and achievement on PLM.

(ii) Intelligence being a major factor underlying academic achievement, correlates positively with the achievement on PLM.

(iii) Though carefully structured PLM should help the low achievers to achieve the criterion, their low intellectual ability may restrict their achievement by not making clear certain concepts, however intelligible they may be.

(iv) Intelligence is not associated with retention scores on PLM as much as it is with the immediate scores on PLM because besides intelligence, there are many other factors which contribute to retention, such as interest in the subject, attitude, the method of instruction etc.

(v) As branching programme makes provision for making errors and rectifying them, low achievers have chances of learning better from the branching programme. This is indicated by the correlation, .36 between branching programme and immediate scores on PLM, which is lower than the correlation, .54, between linear programme and immediate scores on PLM.

(vi) Anxiety is negativaly related to the achievement on both the types of PLM which indicates that anxiety does come in the way of learning through PLMs. A study by Cattell and Scheier (1963) supports this finding. These authors had concluded that in general there was a slight negative relation between anxiety and academic achievement, that is, low anxiety tended to be associated with better grades, high anxiety with lower grades.

(vii) The relation between anxiety and retention scores is lower than that between anxiety and immediate scores on PLMs which shows that being more anxious does not affect one's retention as much it affects one's immediate achievement.

(viii) There is no significant relationship between anxiety and achievement on branching programme. This result indicates that anxiety is not related to the achievement on branching programme.

(ix) There is no significant relationship between self-sufficiency and achievement on both the types of PLMs. This result indicates that this personality characteristic is not related to the achievement on PLMs.

(x) As the correlations between introversion-extraversion and achievement on both the types of programmes are not significant at.05 level, it can be said that being introvert or extrovert does not hamper achievement through PLMs.

The present investigation advocates the use of programmed learning material for the pupils having varied personality characteristics. It also suggests that rather than confining ourselves to the two popular styles of programming, viz., linear and branching, efforts should be made to evolve different styles so as to make programmed learning more effective and suitable for Indian conditions.

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6

Relationship Between Anxiety, Persistence And The Performance on A 'Programme'*

— Here the author reports a study which was designed to find out the relationship between two personality variables (viz. anxiety and persistence) and the performance on Programmed Learning Material. Four groups of students having different levels of anxiety and persistence were selected by administering a test of anxiety and a test of persistence and their performance on a 'programme' was noted. The 'programme' used for this investigation employs the Skinnerian way of programming which requires a student to construct a response overtly. A per-test on Mathematics was administered to all the four groups. Co-variance technique was used for analysing the data. No significant differences in the performance on the 'programme' between the students of any two of the four groups having different levels of anxiety and persistence were revealed.

INTRODUCTION

The present investigation into the relationship between two personality variables (viz. anxiety and persistence) and the performance on a 'programme' is an attempt to probe into the possibilities of utilising Programmed Learning Material (PLM) in a classroom comprising students of varied personality factors.

Some of the studies conducted in the past suggest some relationship between anxiety, persistence and academic achievement. Sarason (1957), Spielberger and Katzenmayer (1959), Cook (1959), Spielberger (1962), Burton (1966) and

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* A part of this research paper was published in Indian Educational Review, July 1973, Vol. 8, No. 2, National Institute of Education, (NCERT), New Delhi.

P. K. GANGOPADHYAY

others found that there exists a significant negative correlation between anxiety and academic achievement. Sarason (1957) found significant negative correlation between 'test anxiety' and measures of scholastic aptitude but a significant positive correlation between 'general anxiety' and college grade point averages (GPA). Spielberger and Katzenmayer (1959), using Tayler's Manifest Anxiety Scale, reported a significant negative correlation between anxiety and achievement. Cook (1959) found that honours students with low scholastic ability had significantly more anxiety than those with high ability. Spielberger (1962) found that there was a negative relationship between anxiety and achievement in students of medium intelligence while in highly intelligent subjects, anxiety facilitated performance. Burton (1966) too found that the high achieving students are not very anxious and not emotionally disturbed. The results given above have also been verified in India by the recent studies conducted by Saxena (1965) and Sinha (1966).

Sarason and Mandler (1952), Malarazzo, Viett, Guze and Saslow (1954) and David and Erikson (1955) did not find any significant relationship between the manifest anxiety and college grade point averages.

Savage (1962) presented evidence for a U-shaped relationship between anxiety and performance. Fein (1963) also found a curvilinear relationship between these two variables. Sharma (1970), in his study also, found a curvilinear relationship between these two variables thus supporting the inverted U-hypothesis. Singha (1971) in his latest study found no relationship between anxiety and academic achievement.

In the area of programmed learning, a study reported by Fishman (1962) showed no significant influence of personality factors on the variability in the prediction of academic performance.

D_ ck and Seguin (1962) studied personality characteristics as related to student performance on programmed learning. In this study, one group of students was paired on the basis of similarity in dominance-submissiveness scores, other group on the basis of dissimilarity. No significant differences were found between the performance on programmed learning material and personality characteristics.

In the study by Lambert, Miller and Wiley (1962), intelligence was found to be significantly associated with the amount of information acquired from the programme. The study by Feldhusen and Eigen (1963) showed that the variance in learning which might be attributed to I Q seemed less essentral than that which might be attributed to general achievement level. In no study I Q perse was found to be the fundamental learner variable in programmed instruction.

The study conducted by Leith (1968) brings in another dimension. Here the instructional method showed a significant positive relationship with extraversion and a significant negative relationship with neuroticism (general anxiety). In other words the greater the degree of anxiety the lower the test score.

A further study by Shadbolt and Leith (1967) showed that the extroverts were more successful than introverts with the discovery type of programme. Introverts were good with the clearly structured and well-guided learning material, though extroverts were significantly poorer with this type of learning. Over all, non-anxious (below the median) subjects were better than anxious ones.

A study was reported by Leith and Wisdom (1969) on the effects of error making and personality on learning. The anxious subjects were found to be poorer than stable ones. This indicates that anxiety does interfere with learning and performance. Trown and Leith (1970) however showed that individuals with greater anxiety (scores above the median) achieved higher, though no significant differences were found.

A number of studies related to persistence and academic achievement have also been conducted by a number of investigators. Fernald (1912), Ryans (1939), Crutcher (1939), Thornton (1940), MacArthur (1951), Burt (1954) and others found a significant positive relationship between persistence and academic achievement. This result has also been verified in India by Bhattacharya (1963).

The possibility thus arises that when the stress of difficulty is avoided, as in small step programmes, personality differences do not emerge, but when the mental effort is greater, as in the studies cited earlier, personality factors have some influence on achievement.

A survey of the earlier researches in the field of personality dimensions as related to the efficacy of programmed learning makes the investigator feel that there is hardly any attempt to study the role of persistence, though a handful of studies included anxiety as one of the variables This was the prime motivation for the investigator to take persistence as one of the personality variables in the present study.

The purpose of the present study was to find out the relationship between anxiety, persistence and performance on a programme.

OBJECTIVES OF THE PRESENT INVESTIGATION

The objectives of the present investigation were as follows :

(i) to explore the effects of anxiety, and persistence on the performance on a programme.

(ii) to explore the existing relationship between personality variables and performance of the students on a programme.

(iii) to explore the possibilities of using programmed learning technique in Indian classrooms.

THE TERMS DEFINED

For the purpose of the present inquiry the following definitions were accepted.

(i) **Anxiety** : In this investigation anxiety means a chronic complex emotional state with apprehension or dread as its most prominent component, characteristic of various nervous and mental disorders.

(ii) **Persistence** : By persistence the investigator means a personality factor which helps one to continue a particular activity despite the obstacles and objections coming in one's way.

(iii) **Performance :** In this investigation the term 'performance' means the pupils' achievement on the criterion test administered after the pupils completed the 'programme'.

(iv) **Programme** : The word 'programme' in this investigation refers to a programmed learning material prepared on the basis of the principles of programmed learning. The programme used for this investigation employs the Skinnerian way of programming which requires a student to construct a response overtly.

SCOPE AND LIMITATIONS

(i) For the present inquiry it was decided to restrict the experiment to English medium school of the city of Baroda.

(ii) The programme selected is a linear one prepared by Shah (1969) titled, "A Programme on Addition and Subtraction of Directed Numbers".

(iii) The present investigation covers only two personality variables, viz., (i) Anxiety and (ii) Persistence. Although many personality variables could be thought of for such a study, the investigator decided to concentrate on two only.

(iv) The sample includes the students of std. VIII only.

HYPOTHESES

The hypotheses made in this investigation were as follows

There are no significant differences in the performance on a 'programme' between the students having

(i) high anxiety-high persistence and high anxiety-low persistence.

(ii) high anxiety-high persistence and low anxiety-high persistence.

(iii) high anxiety-high persistence and low anxiety-low persistence.

(iv) high anxiety-low persistence and low anxiety-high persistence.

(v) high anxiety-low persistence and low anxiety-low persistence.

(vi) low anxiety–high persistence and low anxiety–low persistence.

TOOLS

For the purpose of the present investigation the following tools were used :

(a) IPAT Anxiety Scale

This scale was designed and constructed by Cattell and Scheier (1957). This scale has been widely used by a number of investigatiors in order to measure anxiety. It is applicable to all particularly to the age group of 14 or 15 years and above. The reliability co-efficients obtained by different investigators by test retest, split-half or K-R method were found to vary between 0.80 to 0.93.

The construct or concept validity of the test was estimated by different investigatots and was found to vary from 0.85 to 0.90 for the total scale. The external, concerete validity of the test was found to vary from 0.30 to 0.40 in different experiments.

(b) Persistence Test

This test was constructed by Bhattacharya (1963). Persistence of the high school students can be measured using this test. The reliability co-efficient of the test was found to be 0.75 when measured by test-retest method. The same when measured by split-half method and corrected by Spearman-Brown formula to full test length was found to be 0.71. The validity of the test was also found out by calculating the correlation between the scores on the test battery and the 'teachers agreed ratings'. The co-efficient of correlation was found to be.69.

(c) Programme

For the present investigation a programme in Algebra i. e. "Addition and Subtraction of Directed Numbers" prepared by Shah (1969) was selected. It is a linear programme having 95 frames.

(d) Pre-test

A teacher made test in Algebra was used as the pretest in order to measure the pre-treatment performance of the students on that particular subject. The score range of this test is from 0 to 20

SAMPLE

On the bases of the scores obtained by the students on anxiety and persistenee tests, four groups were formed, the total sample being equal to eighty. Amongst these eighty students, twenty students had high anxiety–high persistence, twenty students had high anxiety–low persistence, twenty students had low anxiety–high persistence. and twenty students had low anxiety–low persistence The sample was drawn from the English medium schools of the city of Baroda.

PROCEDURE

First, the anxiety test and the persistence test were administered to the students. According to the scores obtained by the students on the respective tests students having high anxiety–high persistence, high anxiety–low persistence, low anxiety–high persistence and low anxiety-low persistence were grouped. Then from each group twenty students were randomly selected for the experiment. The test on mathematics (pre–test) was administered to those eighty students and the scores obtained were tabulated. Then the programme was given. As soon as the students completed the programme, the criterion test was administered and the performance of the students on the criterion test was noted.

Co–Variance Technique

Again the four groups were not initally equally matched on the basis of any criterion. So in order to match them equally, analysis of co–variance technique was applied. Here the score of the students on the pretest (pre–treatment performance) was considered as X variable and scores on the criterion test of the programme (post–treatment performance) was considered as Y variable.

RESULTS

The effects of anxiety and persistence on the performance on the programme was tested using the analysis of co–variance technique. The following tables are self–explanatory of the experimental data and results observed.

Table 1 : Name of The Experimental Groups

		PERSISTENCE	
		High	Low
ANXIETY	High	A	B
	Low	C	D

Table 2 : Scores Obtained by the Four Groups on Pre-test (X) and Post-Test (Y)

Group A		Group B		Group C		Group D	
High Anxiety & High persistence		High Anxiety & low persistence		Low Anxiety & High persistence		Low Anxiety & low persistence	
X1	Y1	X2	Y2	X3	Y3	X4	Y4
10	15	8	11	14	11	9	15
12	15	10	10	12	13	4	11
18	12	7	17	10	10	12	13
10	11	12	12	8	14	10	12
4	11	8	13	4	11	7	10
8	12	9	12	10	11	14	11
9	10	10	11	11	12	13	13
7	11	11	10	14	11	6	9
10	10	13	15	11	15	11	8
10	11	6	10	9	12	10	13
8	18	5	10	10	13	12	10
4	11	3	9	7	10	8	11
9	10	12	13	13	9	8	15
12	6	10	12	18	13	10	13
11	11	9	11	15	10	13	12
9	17	8	10	10	11	10	11
13	11	11	10	12	16	11	11
12	13	13	11	7	13	7	9
7	8	9	9	4	11	14	13
8	10	14	10	13	13	3	12

Table 3 : Mean Score Obtained by the Four Groups on Pre-Test and Post-Test

Group	A	B	C	D
Pre-test	9.20	9.40	10.60	9.60
Post-test	11.65	11.30	11.95	11.60

Table 4 : Analysis of Variance of the Post-Test Scores For The Four Groups

Source of Variation	df	S.S.	M. S.	F	Significance
Among means	3	4.25	1.42	.30	Not significant at .05 level
Within Gorups	76	356.50	4.69		

Here F-ratio is not significant (the tabulated value of F .05 is 2.72). This indicates that there is no significant difference on the performance of the programme (i. e. post-test scores) between the students of any two of the four groups.

Table 5 : Analysis of Co-Variance of The Pre-Test and The Post-Test Scores for The Four Groups.

Source of variance	df	s.sx	s.sy	s.sxy	s.sy.x	M.sy.x	Fy.x	Significance
Among means	3	23.20	4.25	7.60	3.20	1.07	.23	Not significant at .05 level
Within Groups	75	687.60	356.50	48.40	353.09	4.70		

Since Fy.x is not significant even at .05 level, it can be inferred that the difference between any two groups on the performance of the programme is not statistically significant. Hence anxiety and persistence have no significant effect so far as the performance of the students on the criterion test of the programme is concerned.

Table 6 : Adjusted Mean of Criterion Test Scores of Four Groups.

Group	N	Mx	My	Adjusted mean My.x.
A	20	9.20	11.65	11.70
B	20	9.40	11.30	11.34
C	20	10.60	11.95	11.90
D	20	9.60	11.60	11.62
	Total No. of Students =80	General Mean =9.92	General Mean =11.62	General Mean =11.64

Table : 7 Significance of Difference Between Adjusted Means of any two Groups.

Groups	Difference between means	Significance at .05 level
A and B	0.36	Not significant
B and C	0.20	Not significant
A and D	0.08	Not significant
B and C	0.56	Not significant
B and D	0.28	Not significant
C and D	0.28	Not significant

Table 7 shows that the differences between the Adjusted means of any two groups are not significant even at .05 level. Therefore all the hypotheses are accepted.

DISCUSSION AND CONCLUSION :

The significant observations of the present experiment may be listed as follows.

(i) It can be seen that the overall differences between the mean scores obtained by the students of the four groups on the criterion test of the programme are not significant at .05 level (Table 4).

(ii) It can also be noted that the differences between the adjusted means of criterion test scores of any two groups are also not significant at any level (Tables 6 and 7).

(iii) The four groups could be arranged according to merit (on the basis of mean criterion scores, Table 3) in the following order : C, A, D, B.

Position	**Group**	**Personality trait**
First	C	Low Anxiety and high persistence
Second	A	High Anxiety and high persistence
Third	D	Low Anxiety and low persistence
Fourth	B	High Anxiety and low persistence

As the differences between the adjusted means are not significant (Table 7), it can be said that the four groups are equally efficient as far as the performance on the 'programme' is concerned.

(iv) There exists no significant relationship between anxiety persistence and the performance on a programme.

The findings of the present investigation are somewhat similar to some of the studies which have already been carried out by different investigators abroad. Leith and

Trown (1970) found that Individuals with high anxiety (score above the median) achieved higher than the Individuals with low anxiety, though no significant differences were revealed. But Leith (1970) got a different result. He found that greater the degree of anxiety, lower the test scores. The result of the persent investigation shows that *there exist no significant differences in the performance on a 'Programme' between the students of any two groups, viz., A and B, A and C, A and D, B and C, B and D, and C and D.*

This finding of the present investigation is supported by the result of Shadbolt and Leith (1967), Leith and Bossett (1967), Wisdom and Leith (1969), Davis and Leith (1969), Leith (1970), and Trown and Leith (1970). In the present investigation, *students with lower anxiety level achieve slightly higher on the criterion test of the programme than the students with higher anxiety, (though the difference was found not significant*).

This result does not support the result of Bossett and Leith (1967), Davis and Leith (1967), Leith and Davis (1969), Trown and Leith (1970). The findings of these studies showed that anxious subjects were better in performance on a programmed learning material than non-anxious subjects. But the principal finding of the other experiments cited earlier was that non-anxious (below the median) subjects were better in performance than anxious ones. The result of the present investigation some what supports this contention, though the difference was not found statistically significant.

As mentioned earlier, the result of the present investigation thus show th t *anxiety and persistence have no significant effect on the performance on a 'programme'*. It can, therefore, be concluded that in the programmed learning technique, anxiety and persistence do not interfere with learning and performance. Hence it can be said that the programmed learning materials may cater to the needs of pupils having different personality traits.

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7

Using Programmed Learning for Remedial Teaching in a Rural Area: An Action Research

—The paper provides an idea as to how a programme could be used, with profit, as remedial material to bring up the under-achievers in Algebra. The low achievers were located from two divisions of std. VIII of a rural school keeping in mind IQs measured by Shah's Nonverbal Group Test of Intelligence and pretest scores in algebra based on the pretest prepared for diagnostic purposes. Forty nine underachievers were administered Shah's programme on 'Addition and Subtraction of Directed Numbers' followed by the readministration of the criterion test. Comparison between the initial and final mean scores on the test showed considerable improvement. Here is an experiment conducted on a small sample with only one programme on a topic in algebra, which restricts the generalisability of the findings to a great extent because of low precision. Observations made should, therefore, be viewed with reservations.

Though programmed learning in India is still in the stages of early experiments and primary applications, the idea is not quite unknown to the world of education. This new technique of instruction is gaining momentum much to the credit of a few organizations and persons who take deep interest and initiative to propagate the idea through seminars, training courses, conferences, publications and researches. Researches carried out in India and abroad have proved its effectiveness and multifarious uses in the process of instruction. Lysaught and Williams (1966) seem to

G. B. SHAH AND G. G. KAPADIA

be correct when they say that programmed instruction is useful at every stage of the continuing educational process. Experimental work has indicated its applicability at the pre-verbal level and in such areas as the instruction of retarded children. Teachers and training specialists, therefore, should use auto-instructional materials in the light of curriculum needs and special requirements, such as enrichment, remediation and review.

That performance by programmed learning is better and helps in retention was found by Gagne and Dick (1962). The immediate post-tests, both verbal and performance, revealed a considerable amount of learning, a little over 90 per cent of which was retained after six weeks. The correlation between verbal and performance tests was 0.69 and between the verbal and performance retests, 0.73. The correlations between these test grades and the students' previous mathematics grades ranged from 0.50 to 0.53.

That programmed instruction is more effective than conventional instruction and that the pupils learn in a shorter period through programmed text, was revealed by the study of Hughes and McNamara (1961). The results showed that programmed textbook classes completed work in a mean of 8.8 hours, with large individual variation. Conventional classes took 15 hours. Experimental groups scored slightly higher. Students were favourable to programmed work.

A similar study by Shah (1969), carried out in the Indian situation, established the superiority of the auto-instructional programmes in respect to the learning achieved and the time needed over the conventional method. One interesting aspect of the study was that she made standard V children learn standard VIII algebra through auto-instructional programmes. It worked well except that the students of std. V needed explanation of a few technical terms while going through the programme, and they took almost double the time.

Oak (1971) found that the highest percentage of errors on the programme was only 4.29. On the criterion test also, only two students showed a percentage of errors exceeding 10. The time taken by the seventh graders to learn 'ratio and proportion' by a programme was half as much as the time taken by those who learnt it by the traditional method. An opinionnaire given to the students to know their attitude towards programmed material revealed the following.

1. Students consider programmed material quite useful.
2. They appreciated the fact that programmed material facilitates concentration and independent study.
3. They liked especially the self-pacing nature of programmed material.
4. They felt that the experience of success motivated them in their further attempts.
5. In general, the students preferred programmed material to the traditional methods.

Hussain (1971) studied the effectiveness of linear and branching programmes in two situations—rural and urban, and under two different conditions—supervised and unsupervised. The analysis revealed that the linear supervised treatment was superior to all other treatments in the urban situation. In the rural situation, branching supervised treatment was superior to all other treatments. Linear non-supervised treatment is significantly inferior to all other treatments in urban as well as rural areas. The analysis also indicated that linear programmes work well when given under the supervision of the teacher. Branching supervised and non-supervised treatments proved to be equally effective, though fhe branching supervised treatment was slightly better than branching non-supervised treatment.

Kulkarni's study (1968) revealed that achievement of pupils is greater in a particular subject if the lesson is revised by using a programme, compared to other conventional methods of revision or no revision at all.

Programmed material was used by schools in a variety of ways in U. S. A. School systems, both urban and rural, also tried to find a flexible use of programmed materials. As brought about by Kulkarni (1970), in some schools, programmes were used for remedial work. On the bases of the pretest scores if it was found that a student lacked certain pre-requisite knowledge, these deficiencies were removed through assigned independent work employing programmed material. Even in regular classroom instruction, if it was found that the student had trouble with a certain topic because of a variety of reasons, programmes were used to remedy his deficiency.

A common complaint is that all the innovations and new ideas originate and remain within the boundaries of the urban area and the masses in the rural area are usually ignored. This cannot continue for long in this era of mass education, in a democratic society, where all children are entitled to receive education according to their abilities. In the present study, the programmed learning technique was used in a remote village, Dehli, of Valia Taluka in the Broach District. The area is known for its adivassi population.

THE PROBLEM

The democratic philosophy of education implies an educational programme which suits each pupil and helps him develop as far as his potentiality permits. This takes care of underachievers, retarded children, gifted children, etc. The present study deals with scholastic underachievement in mathematics and remedial teaching for improvement in achievement.

The scope of this study is delimited to algebra, more specifically, to the topic of directed numbers which is taught to the pupils in the beginning while introducing algebra in std. VIII. A thorough knowledge of directed numbers is so essential for the study of algebra that without it further study of algebra is almost impossible. It is, therefore, very necessary to undertake remedial measures for the underachievers at the very outset.

It was in this context that the investigators thought of making an inquiry into the effectiveness of programmed material when used for remedial teaching for the underachievers in mathematics, in a rural area. It is commonplace to consider mathematics a dull and drab subject. This popular misconception gets support from the fact that a good number of students actually dread Mathematics. It may be because the fundamental concepts are not clear from the beginning. The notions of 'plus', 'minus', 'zero' and the addition and subtraction of positive and negative numbers seem to be very crucial in the teaching of algebra. It was thought that an attempt to help the students develop conceptual understanding of these fundamental notions would be quite profitable.

DEFINITION OF TERMS

The clarification of the following terms would help get better insight into the present inquiry.

Shah (1964) grouped the underachievers into the following three categories.

(i) Dull Pupils : Such pupils are backward only due to lack of intelligence.

(ii) General Backward Pupils : Such pupils are not dull in the real sense but their backwardness is due to adverse circumstances.

(iii) Specifically Backward Pupils : Such pupils are backward in arithmetic or algebra or in any other subject like English or Sanskrit.

The underachievers of the present study belong to the third category.

Underachiever in Mathematics : A pupil is said to be an underachiever in mathematics when his achievement in mathematics is low and his intelligence is not less than normal.

Normal Intelligence : A pupil is said to possess normal intelligence when his I. Q., measured by a standardized intelligence test, is between 85 and 110. The intelligence test used for the inquiry was the Non-Verbal Group Test of Intelligence prepared by G. B. Shah.

Low Achievement in Mathematics : Achievement of a pupil in mathematics is considered to be low when he scores less than 40 per cent in the subject.

Programmed Material : A teaching unit or sub-unit, planned and organized in such a way that a learner can learn by himself, going through it step by step. Programmed material or a programme is based on the principles of programmed learning.

The programme used for the inquiry was the one on Directed Numbers prepared by G. B. Shah. It includes addition and subtraction of directed numbers and contains 95 frames.

SAMPLE

The sample for the inquiry was derived from the two divisions of std. VIII of a rural school. Those pupils were termed as underachievers :

(a) whose intelligence quotient was not less than 80; and

(b) whose score in mathematics on the pre-test was not more than 40 per cent.

The achievement in mathematics was determined by administering a teacher-made test.

CONDUCT OF THE EXPERIMENT

In the beginning of the study, Shah's Non-Verbal Group Test of Intelligence was administered to all the pupils of std. VIII. A pretest in algebra was also given to the same pupils. The pretest was prepared for the diagnostic purpose of determining the actual deficiencies of the pupils.

The underachievers were located on the bases of their I. Q. and achievement in the pretest as mentioned earlier, and their specific errors were detected from their performance on the pretest.

The next step was to give remedial teaching. The following two points are involved in remedial teaching.

(i) Remedy in the method of teaching, and

(ii) Removal of errors through intensive class work.

In the present experiment, a programme on "Addition and Subtraction of Directed Numbers" was given to the underachievers selected on the basis discussed in the previous lines. It should be remembered that this programme was not used as a substitute for the teacher in charge, but as an adjunct to his normal teaching.

Administration of the programme was followed by giving the same test which was given before the experiment was started. The pretest and post test results are given below.

DISCUSSION OF RESUILTS

It should be noted that the experiment is concerned with the significance of the difference between correlated means obtained from the same test administered to the same group on two occasions. This experimental design is called the 'single group' method and it attempts to estimate the effect of the activity interpolated between test and retest.

The formula (Garrett, 1965) used to find out the significance of the difference between the two correlated means was :

$$SE_D = \sqrt{\sigma^2_{M_1} + \sigma^2_{M_2} - 2r_{12}\sigma_{M_1}\sigma_{M_2}}$$

where (i) M_1 and M_2 are the standard errors of initial and final test means,

(ii) r_{12} is the coefficient of correlation between scores made on initial and final tests, and

(iii) SE_D = Standard error of the difference between correlated means.

Table 1 : Comparisons Between the Initial and the Final Mean Scores

Details	Initial Test	Final Test
Number of children	49	49
Mean Score	26.7 (M_1)	76.5 (M_2)
Standard Deviations	19.0 (σ_1)	10.3 (σ_2)
Standard errors of means	1.43 (σM_1)	1.47 (σM_2)

Difference between the means = 49.8
Correlation between initial and final tests = .20

Since we are concerned with progress or gain this is a one-tailed test. Substituting the formula given above, we get

$$SE_D = \sqrt{(1.43)^2 + (1.47)^2 - 2 \times .20 \times 1.43 \times 1.47}$$

$$= 1.83$$

The 't' ratio is 49.8/1.83 or 27.2. Since there are 49 children, there are 49 pairs of scores and 49 differences so that df becomes 49-1 or 48. The 't' for 48 df is 2.40 at .01 level. The obtained 't', therefore, is far greater than 2.40 and hence it can be considered very significant. It seems certain that the underachievers made substantial progress in mathematics. The progress made by the underachievers in mathematics can be safely attributed to the programme because that was the only interpolated activity between the pretest and the post test.

The results discussed in the previous lines point to the possibility of using programmed learning material for remedial purposes in remote villages. It is a fact that our rural schools do not often have competent teachers. Skinner (Shah, 1969) maintains that programmed instruction has great future in a developing country like India. In a message written for an Indian book on programmed learning in Gujarati he writes......A shortage of teachers is offset in two ways : (i) existing teachers can work more effectively by encouraging individual study and (ii) programmes can be developed and disseminated in the areas where teachers are not yet available. According to the Second All-India Educational Survey (1967) there are 2,77,137 teachers in secondary sections in India out of which 46.52 percent are in rural areas. The percentage of trained teachers in rural areas is 63.59. The percentage of teachers who are matriculates or below is 18.88 in Gujarat. In such a situation, programmed learning material can prove to be of great help to teachers, especially to untrained teachers or teachers who are matriculates or below.

Such a fascinating strategy as programmed learning should be exploited in as many ways as possible, and in as many areas as possible in order to derive maximum benefit from it.

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8

A Conspectus of Studies in Programmed Learning

Like all innovations in education, programmed learning is likely to meet with reluctance and even resistance. Uncritical acceptance of a new idea or a practice is the surest way to kill the same. It is, therefore, inevitable that there prevails some doubt with regard to the worthwhileness of programmed learning. Such a doubt should become a starting point of research in the area of programmed learning. There have been a number of studies in this area since 1954. As Schramm (1964) pointed out, no method of instruction had ever come into use surrounded by so much research activity; indeed, for a while it seemed that there would be more research than programmes.

Fry (1963) attempted to provide classification of variables in a programmed learning situation and discussed how such a classification could help consumers, producers and researchers. He based his classification keeping in view the following A to Z factors :—

A. Step-presentation Media (sensory input)
B. Type of Symbol Used in Steps
C. Step Characteristics
D. Mediating Activity (between stimulus and response elements)
E. Response Mode (form of response)
F. Response Ideational Content
G. Knowledge of Results
H. Reward or Reinforcement Type

G. B. SHAH

I. Reward Variations
J. Presentation Rate
K. Branching Patterns
L. Branching Control
M. Repetition Practice
N. Discrimination and Generalization
O. Programme Length
P. Programming Techniques
Q. Subject-matter Organization
R. Subject-matter Characteristics
S. Coordinate or Supplementary Presentations
T. Motivation Factors
U. Environmental Influence
V. Individual Differences
W. Measurement of Outcome
X. Training Efficiency
Y. Quality of Programme
Z. Educational Objectives (from Bloom, 1956)

It should be noted that Fry's classificatory analysis provided an outline for research in the field. A year later it was Schramm who came out with the book, "The research on Programmed Instruction-An Annotated Bibliography". The bibliography was prepared under a contract with the Institute for Communication Research at Stanford University by a national authority on new instructional media. The bibliography covers the review of studies completed by about February 1963. Leith (1963) reported the researches in the field under the following ten categories :—

1. The efficiency of programmed instruction in comparison with classroom teaching and learning.
2. Methods of presenting programmed materials.
3. Methods of programme construction.
4. Mode of response.
5. Rate of response.
6. Method of verification.

7. The relationship of programmed learning to intelligence.
8. The scope of programmed learning.
9. Teaching methods.
10. Theoretical problems.

Kulkarni (1972) reviewed some studies conducted in India. "Most of the studies conducted in India were done keeping in view the specific situations in India". He tried to report the findings in regard to the following questions :

(i) Does instructional material prepared on programmed learning principles teach better or at least equally well in comparison with the conventional methods ?

(ii) What would be or should be the teacher's role in the context of programmed instruction ?

(iii) What about the attitude of the learners while going through programmed instruction ?

Shah (1972), instead of surveying the whole field of researches in the area, reviewed the studies made in relation to response modes in programmed learning.

In the present paper it is proposed to provide a conspectus of studies and a summary of broad generalizations.

It should be noted that the purpose, here, is to review the findings of research in the field with a view to highlighting certain implications for the future of the movement in developing countries. Certain omissions in the paper should be seen in this context. Certain methodological issues have been raised toward the end of the paper so that further investigation in the field could be taken up on sounder methodological basis.

Let us begin with some descriptive studies. These include questionnaire studies, attitudinal surveys, comparative surveys and simple experiments wherein various intervening variables are not controlled.

Kulkarni and Dewan (1967) tried to apply the principles of programmed learning to television lessons. The TV presentation of a question, followed by responding by the students and feedback, enabled the students to score much higher. Sarkar (1969) used programmed material for industrial training in his experiments with workers of Gujarat State Fertilizers Corporation (GSFC) and found it quite effective. Kulkarni and Mullick (1968) planned a correspondence lesson unit in Statistics, both in the conventional way and in the programmed way. The results were in favour of the programmed lesson. Gupta (1968) adapted a programme in physics and found that considerable time of subject matter specialists could be saved if such programmes are revised on the bases of local tryouts. The cost could also be reduced by employing representation procedure which might involve group pacing as is done by presenting the material through roll-up boards. Krishnamurthy applied the programmed learning technique in the training of family planning workers and found it more fruitful and less time-consuming.

The experiments mentioned above were done with a view to trying out programmed learning procedures in a spirit of action research. Let us now turn to some inquiries made at a little higher level of precision.

Alter (1962) tested the subjects twice : immediately, and again after a retention interval of 2 to 3 weeks. More intelligent students performed better on the retest than less intelligent students.

Brooks (1961), in his Ph. D. dissertation, explored the relation of latency of answers to errors in programmed materials. The data supported the view that longer latencies tend to go with errors. Latency was found to be more sensitive than error rate as a measure of difficulty.

Eigen (1963) surveyed student reaction to programmed instruction. In general, students using the programmed text had a more favourable attitude toward programmed instruction than did those using the teaching machine. Student's total attitude toward automated teaching, however, appeared to have no relationship to how much they have learned by the method. He concluded that it is difficult, if not impossible, to conceive of a typical reaction to controversial statements about programmed instruction after a student's first exposure. Attitudes vastly differ from student to student.

Feldhusen and Eigen (1963) conducted a correlation study and inquired into interrelationships among attitudes, achievement, reading, intelligence and transfer variables in programmed instruction. The authors concluded that "attitudes of students toward programmed instruction are not consistently related to the youngsters' levels or amounts of learning".

Ferster and Sapon (1958) found no correlation between aptitude and achievement in learning from a programme. They reported, however, that in a mean time of 47. 5 minutes, the six students learned an amount of German comparable to that presented in a first semester course.

Gagne (1962) experimented on seven ninth grade boys to explore effectiveness of a learning programme designed to transfer training from component learning sets to a new activity which incorporated these previously acquired capabilities. Six of the seven boys were brought to successful achievement through ascending hierarchies to the final task goal.

Goldbeck, Shearer and others (1962) integrated programmed learning with conventional classroom teaching. They found that a few minutes a day of programmed learning integrated with conventional classroom teaching could raise student performance significantly higher than conventional classroom teaching alone. Furthermore, student attitudes were favourable to programmes used this way and tended to become more favourable with longer acquaintance. This experiment has added relevance for all developing countries like India, because such an adjunctive use of programmes is going to be a practical proposition for years to come.

Hickey and Anwyll (1961) looked into effectiveness of programmed learning in industry. He used the programme on 'Procedures of Package Billing' and found 34 per cent reduction in average number of student hours needed to attain the criterion level of performance.

Hickey and Laidlaw (1962) tried out programmed material on "Retail sales and ship's store Management" on U. S. Navy Supply Officers. The student who used the adjunct programme saved 56 per cent of usual homework time (17 per cent of usual overall study time) in reaching the performance criterion. Instructor's lecture hours were reduced to 54 per cent. Attitude was generally favourable.

In addition to the descriptive studies mentioned above, there are experimental studies worth mentioning here. It should be noted that experimental studies on response mode and personality variables, in relation to programmed learning material, have not been included here because they have been mentioned elsewhere in the book.

Alter, Eigen and King (1962) studied the effect of different kinds of reinforcement. In the experimental group, correct responses were confirmed by telling the students they were correct. One group was, in addition, given small trinkets for the first five correct responses, and thereafter, for about twentyfive percent of the correct responses. No significant differences in learning or test performances were found.

Angell and Lumsdaine (1960) compared a condition in which the subject was prompted on every item with one in which he responded without prompting on every fourth item. The condition of partial prompting resulted in significantly more efficient learning. The results supported the theoretical expectation that the learner should not only be helped to respond correctly, but should also be given some practice in responding without the help of prompts.

Angell and Lumsdaine (1962) found that when students were tested immediately after finishing the programme, scores for the vanishing and the non-vanishing version of the same programme did not differ significantly. However, scores on a delayed retention test were significantly higher for the vanishing than for the non-vanishing treatment.

Beane (1962) found that the branching programme was more efficient than the linear programme, timewise. The students expressed more favourable attitudes to word the linear programme.

Briggs (1961) compared self-pacing with automated pacing. One group worked at its own pace; the other group was, paced, automatically, at the rate of about 13 seconds per item. No significant differences were found in the post-test performance of the two groups.

Krumboltz (1963) studied the effectiveness of key-word response vs. trivial-word response in programmed instruction vs. reading of the same material in paragraph form. On immediate and delayed post-tests, the key-word and paragraph formats scored about the same, and the scores were significantly higher than the trivial-word group.

Moore and Smith (1962) studied the effect of different kinds and amounts of reinforcements on learning. Different experimental groups were given (a) no knowledge of results; (b) correct answer after each response; (c) a flashing light after the correct response; (d) one penny for each correct response; (e) a programme with response blanks filled up in advance. No significant differences in learning were found among the groups.

Smith and Moore (1962) studied the effectiveness of programmed instruction by machine, programmed text book plus a weekly seminar vs. text book plus a weekly seminar. No significant differences in achievement related to teaching machine, programmed text or conventional text book were found. They also studied the effectiveness of teaching machine programme, programmed text-book, and conventional text book without supplementary classwork. Machine group scored significantly higher than conventional text group, both on immediate and delayed post-tests.

It should be notəd that there are many other studies worth mentioning. Here some typical studies have been mentioned which bear some relevance to situations in developing countries.

SOME BROAD GENERALIZATIONS

Researches in the field of programmed learning have turned out some broad generalizations. These generalizations should not be taken as final. Below are given some of the important generalizations.

Learners of all ages and stages in schools, colleges and industry show favourable attitude toward programmed material. It should be noted, however, that over a period of time the element of novelty wears off and programmes are found boring. According to Leith (1963), programmed learning prepared and guided by well-informed teachers, is a cheap and effective mode of instruction, the possibilities of which have not been fully revealed. It has already shown itself to be a helpful adjunct to other methods of teaching. Comparisons between programmed material and traditional teaching often favour the programme, especially in terms of time. The results, however, should not be regarded conclusive because variables like novelty effect, personality involved, and time spent are not controlled. There are reasons to believe that integrating different techniques is preferable to using only one. Smith and Smith (1966) concluded that simple teaching machines and programmed books appear to be equally effective. According to them most, but not all, of the research on step size favours small steps over large ones. Such research is more relevant if discrete-step programmes are to be used for initial presentation of the subject matter. For short programme sequences, the order of frames can be randomized without affecting learning seriously.

Linear and branching styles have proved to be equally effective and have shown few significant differences. Remedial branching seems to be more effective when it is based on self-evaluation as well as on error responses.

Traditional text material proves to be as effective as, or more effective than discrete programme frames in promoting learning (Smith and Smith, 1966).

There is no conclusive evidence that errors, as such, are detrimental to learning if they are corrected immediately and if the learner understands why he was wrong. The easy programmes do not always promote the highest achievement scores.

Covert and reading modes-not unexpectedly—take less time, and are consequently, more efficient. It will be important to discover if overt respoding is more efficient with the younger and less able pupil, and whether amount of previous knowledge is an important factor (Leith 1963). Shah's findings (1972) support Leith's generalization with regard to effectiveness of covert response mode.

Whether self-pacing is important where the ability range of pupils is wide, and with larger programmes, has still to be determined, but on the assumption that pupils are ready for the course and that there is a low error rate, it seems possible to control the rate without lowering efficiency.

There are indications that far more significant phases of research in programmed instruction are under way. It is hoped that necessary modifications in the nature of programmed learning material would be made from time to time in the light of further explorations.

SOME PRACTICAL ISSUES

Experimentation in the field of programmed learning has revealed some practical problems with reference to the situation in India. Systematic research in programmed learning has just begun in India and certain difficulties seem to be inevitable.

(i) Paucity of Programmes

Programmes, good or bad, are a scarce commodity. The Centre of Advanced Study in Education at Baroda compilted a directory of programmes (printed and mimeographed) in the IAPL NEWSLETTER. Teachers and researchers the country over began to ask for some of the programmes and even expressed their willingness to pay. In about 99 per cent of the querries, the answer was that the programme(s) couldn't be spared as there was only one copy with the Centre.

The situation is further aggravated by the fact that in certain subjects there are very few programmes. A comparatively good number of programmes have been prepared and even published in subjects like Mathematics and Science. Technical Teachers' Training Institute, Madras has published about 18 programmes on engineiring subjects. These subjects, it is argued, lend themseeves to programming better, perhaps because they are more analysable conceptually and in terms of definable behaviours. In most of the research projects taken up in the late sixties, the investigators had to prepare the programmes before they could develop the experimental designs. The studies of V. Krishnamurthy and G. G. Kapadia could be mentioned here. These two investigators received training in preparing programmes and then prepared the programmes after they were registered for their doctoral work. In other words, they had to spend about a year before they could collect the data. In such a situation, research in programmed learning seems to be quite time consuming.

The directory of programmes also revealed that most of the programmes were prepared for the secondary school pupils. There were very few programmes for the lower primary, higher primary and college level students. Furthermore, there were very few programmes in subjects other than the school subjects. The programmes on units related to language teaching were very few.

(ii) Quality of the programmes

The directory of programmes mentioned above included all sorts of programmes including some which could hardly be called programmes. It also included the programmes which were never tried out either at individual or field-testing stage. Some of them were tried out without subsequent correction and validation. It should be mentioned here that the practice of giving out the validation data along with the printed programme has not yet been traditionalized. A researcher or consumer, therefore, has no way to judge the quality of a programme before he begins to use the same. Generalizations based on such a programme remain dubious and even misleading at times.

(iii) Cooperation from Schools

Most ot the data in the field is collected from the schools by giving the programmes to the pupils. Schramm (1964) points out that it is often very difficult to extrapolate findings on short programmes to the conditions of classroom use. Programmes with more than a hundred frames present some problems and a researcher has to struggle hard to face them squarely. Let us take some main problems :

(a) In programmed learning, the learners go at their own pace. A programme which, on the average, requires an hour actually requires an hour and a half so that the slowest in the class could also complete the programme. In some cases it is found that the slow learners require almost double the time required on the average. The situation can well be imagined when a programme is long enough to take more than three hours and when it requires to be completed in three to four sessions.

(b) Programme administration needs to be followed by administration of the criterion test. In some cases it should be preceded by pre-testing to ensure the required entering behaviour. The researcher may also like to collect retention scores of the subjects after a month or so. It is rather difficult to convince the school administrators and the teachers to part with so many class hours. Sometimes they might not see any obvious advantage in allowing a research worker to take so much time.

(c) Some experimental designs require randomization procedures for subjecting various groups of pupils to different experimental treatments. If the instructions are common for all the treatment groups they might be allowed to sit in the same room. There are some treatments which might require as many rooms as the number of treatments. In such a situation the problem of accommodation takes a very serious turn even if the principal is willing to cooperate.

(d) For most of the pupils, learning the programmed way is a novel experience. They seem to enjoy learning the programmed way when they take it seriously. All the same, there are situations when they do not take it seriously, specially when they know that it has nothing to do with their examination and the course. There are some attitudinal problems also. For example, a programme on 'Functioning of Our Heart' is likely to be taken seriously by the nineth graders in Gujarat if the teacher has not covered the 'heart' before the programme is given. If he has covered the topic, the only alterantive before the research worker is to administer the same programme to the eighth graders and collect the data. It is found that our examination-minded pupils do not take a programme seriously in a situation like this. The researcher, and in most cases, the programmer-cum-researcher gets frustrated if he fails to achieve the proverbial 90-90 criterion.

(iv) Administrative Problems

Preparing a programme is a time-consuming process.

The programmer might take days before frame writing begins. He has to develop, after thorough thinking, the statements for entering behaviour and terminal behaviour. He has also to develop the pre-test and the criterion test. He might like to develop these before frame writing. He should prepare a scheme for task analysis. All these he has to do keeping in mind the specification of behaviour. He cannot afford to be verbose by using non-behavioural terms like 'understanding', 'knowing', 'developing a concept' 'appreciating', etc. The terminal behaviours listed by him are to be 'achieved' when the programme is administered and he just cannot be over ambitious. At every step he is required to consult a subject-matter specialist who might not readily oblige him.

After the first draft is ready the programmer goes for individual testing, to be followed by redrafting of the frames whenever necessary. The field tryout and editing require a lot of time. All these steps, if scrupulously followed, take months before the programme can go to the press.

The administrator takes some time before he can reconcile to the 'gross' delay. He is tempted to say, "Why not prepare programmes covering the entire syllabus on statistics at the B. Ed. level this year?" Production emphasis, sometimes, does not go hand in hand with research in programmed learning and the net result is frustration on the part of the researcher. Sometimes the ill-informed administrators go to the length of toying with the idea of mass production of programmes without any concern whatsoever for quality.

Then there is the problem of cost. An individual research worker finds it difficult to take up a study in programmed learning unless there is financial support. The cost of printing might prevent him from selecting a bigger sample as he has to manage within a stipulated amount.

Moreover the press sometimes seems to feel reluctant in accepting the manuscript full of vertical and horizontal lines on all the pages. They, instead of saying no, ask for higher rates. The cost factor sometimes gets contounded with labour factor. This may lead the researcher to go for undue compromises with regard to sampling, experimental design and even quality of the programme. He might even feel tempted to advise his colleagues not to take up programmed learning as a field of research.

The problems mentioned above should not dishearten a budding researcher who wishes to probe the field of research in this area. Many of the problems mentioned above would be solved when we would have a large number of programmes on a wide range of subjects. A researcher in the field of programmed learning wouldn't necessarily be required to develop a programme before he begins to research. He, then, would be able to collect the data on the programme(s) prepared by somebody else.

SOME METHODOLOGICAL ISSUES

The practical issues discussed in the previous lines give rise to the problems of methodology of research and experimental design.

I. Difficulties in Sampling

Time-consuming programmes, coupled with tests, restrict the size of samples selected for experimentation. Tests, other than the criterion test, are sometimes needed for controlling certain intervening variables like intelligence socio-economic status, scholastic achievement in the subject(s) concerned and initial test score on the programmed unit etc. Although it is quite conceivable that experimental research does not necessarily require a big sample, it does require adequate controls to maintain the experimental situation. Take, for example, a research situation wherein five different forms of programmed learning material are the experimental treatments or say, independent variables. Here there are three alternatives before a researcher :

(i) He may select a division or a school with more than one division and form the five groups of pupils by random selection for administration of the programme along with the test(s) in a bigger room.

(ii) He may take more than a division in a school and go for as many replications as there are divisions in the school. This would neither require a bigger room nor would the normal divisions be disturbed. Such a practice would be more time consuming.

(iii) He may take more than one school and go for as many replications as there are schools by utilizing bigger rooms to accommodate more than one divisions, if necessary. The problem of school-to-school variation can be avoided only if he can manage to get a very big hall to accommodate pupils from all the schools.

Generalizability of the findings from researches in programmed learning remains questionable even after the problems of adequate size of the sample and maintenance of experimental situations are solved in some way. Issues such as the following crop up before one can really generalize anything :

* What is true for the urban schools may not be equally true for the rural schools.

* Effectiveness of a particular experimental treatment may vary from stage to stage: primary, secondary and university.

- * What holds for a programme in mathematics may not hold for one in English.
- * What holds for short programmes may not hold for long programmes.
- * What holds for a linear programme may not hold for a branching programme.
- * Within the same subject also, effectieness of an experimental treatment may vary from unit to unit. Some content areas in a subject may be information-based while some may call for conceptual understanding.

Problems of sampling in the context of researches in programmed learning are twofold :

(a) sampling of the subjects for experimentation
(b) sampling of the subject-matter (sample of behaviour).

Both these aspects deserve to be carefully attended to before arriving at any conclusion. Findings of research in this field should, therefore, be accepted with due reservations.

II. Null Hypothesis

Fisher (1951) made the point long ago that the null hypothesis can only be disproved, it cannot be proved. The problem of sampling is closely linked up with acceptance or otherwise of the null hypothesis. Schramm (1964) wrote, "The numerous experiments on programmed instruction that do not succeed in disproving the null hypothesis may, indeed, be proving that no significant difference exists, but the suspicion arises that in many cases the programmes are too short, the samples too small, the measuring instruments too dull, to pick up differences if they exist".

Leith (1963) feels that it is difficult to know, in the case of many experiments, whether failure to reject the null hypothesis occurs because there are, in fact, no differences or because the programme is too short, the number of subjects too few, or the between-subjects variation too large.

In the field of programmed learning a large number of studies report 'no significant differences' which gives us less information than a finding of a difference. In case of a difference, a researcher can know with statistical techniques, the likelihood that his finding is due to chance. When he reports no difference, he has 'no logically defensible basis' as pointed out by Lumsdaine. In case of studies in programmed learning, the likelihood of Type II errors seems to be much higher when a researcher accepts a null hypothesis by marking a difference not significant.

III. Minimal Errors

An error in programmed learning situation implies a response not acceptable to a programmer. Error rate refers to 'the percentage of incorrect response on an item, a set of items, or a whole programme'. Markle (1964) has pointed out 'spuriously low error rates are too easily attained by adding irrelevant easy terms, testing with a pretrained population, removing terminal items, etc.'

According to Skinner (1961), the programmer must 'keep refining his programme untill the point is reached at which the answer of the average child will almost always be right'. The programmers, especially the linear programmers, seem to toy with the idea of achieving the 90-90 criterion which requires that 90 percent of the pupils should be correct on 90 percent of the items. Carried to its logical extreme, one can say that, in general, the more a programme is revised to produce errorless learning, the longer it gets.

Apart from theory, it is generally found that the much talked about 90-90 criterion is hardly achieved in practice. Achievement on the criterion test, followed by programme administration, depends on the effectiveness of the programme and the nature of the test. In a programmed learning situation the criterion test items are never subjected to item selection procedures in terms of difficulty values and discriminative indices. At the most, the programmer takes into account the curricular validity.

It is not difficult to prepare parallel forms of the criterion test with curricular validity kept intact but with varying difficulty levels. In such a situation, the criterion should be accepted with a pinch of salt and that too in spirit. It remains a worthy ideal to be achieved, at least in the Indian context. In developed countries like the U.S.A., such a critierion is mostly achievable even in a normal situation in the classroom. In India, where about 50 percent of pupils somehow get through, it is difficult, if not impossible, to achieve the criterion in actual practice.

IMPLICATIONS FOR FURTHER RESEARCH

In spite of reservations expressed, difficulties listed and limitations mentioned, the fact remains that programmed learning has come to stay. Our endeavour should be to make the best of it keeping in mind the financial, socio-cultural and educational implications for the developing countries. It is well to remember that we have single teacher schools, teacherless schools and even schools without pupils. Buch (1972) has summarised the anomalies in Indian education as under :

1. Even though the number of schools increased, the goal of providing free and compulsory education to children in the age group 6-14 receded further.
2. More institutions for teacher preparation came up but the quality of teacher training deteriorated.

3. More money began to be spent for improving teacher preparation programmes but at the same time outdated practices persisted.
4. Modernization came to be discussed more and more and traditionalism continued to be practised all the same.
5. Greater pressure was put on schools to be innovative and greater was the resistance shown by the colleges of education to change.

Research in programmed learning can not prove worthwhile if these realities are ignored. In India the per capita expenditure on education and science is Rs. 16/- only. It seems reasonable, therefore, to inquire into the factors related to (a) cost and (b) priorities.

(a) Cost

The following points could be considered while taking up problems related to cost of producing a programme both money-wise and labour-wise.

- Which response-mode lends itself better to minimum printing cost due to fewer number of pages required.**
- Which size of a programmed book is best suited to more coverage of the matter on a page. This might have something to do with the pattern of presentation—horizontal or vertical.
- Which size of the book results in cost reduction. ‡

** G. B. Shah's paper in this book throws considerable light on the aspect of cost in relation to response modes. It deserves further probing.

‡ G. G. Kapadia has prepared a programme on 'Heart'. The cost was reduced to almost 70 per cent because of proper selection of size. The advice came from the printer and not from a researcher.

- What are the financial implications of using a separate answersheet for a programme ?
- What about the relative durability of a programme printed on paper of varying quality ?
- How many pupils of a particular age-group can use a programme with separate answersheet, before it gets soiled ?
- How can the cost of a programmed text be reduced by printing a large number of copies ?
- What can be the optimum price for maximum sales of a given programme ?
- Grant-in-aid provisions for purchase of instructional material such as programmed texts.
- Implications (financial as well as educational) for a private publisher coming out with programmes on a wide range of units from school subjects.
- Man-hours or man-days required to plan, prepare, try-out, edit and find out a programme of a given size.
- Which form or style of programming require less labour (linear, branching or hybrid branching style) ?
- Financial implications for programmes published in English, Hindi and regoinal languages (sales are affected by clientele).
- Which strategy of work is labour-saving :
    - one person doing everything ?
    - a team of persons doing specific jobs ?
    - an expert assisted by hired personnel ?
    - a team of experts ?

- Whether semi-programmed text-books could be prepared in less time and with less money.
- Whether we could save labour and money by adapting the programmes published abroad. What are the implications (copyright etc.) of adapting such programmes ?

It should be noted that efforts to reduce the cost of production of programmes would go a long way in increasing its use. Knight rightly points out that it is not enough to show that a programme teaches; it must also do so efficiently. While thinking about cost of a programme, one must take into consideration the pupils' time and labour also. It is good to ask : could we reduce the size of a programme without loss of effectiveness ? "Several experiments have shown that programmes may be shortened without loss of effectiveness" (Hawkins, 1970).

Our attempts, therefore, should be directed toward making a programme as little expensive as possible and at the same time as efficient and effective as possible.

(b) Priorities

Scarce resources call for a careful consideration of priorities. The financial input must bring maximum dividend in the form of improved quality of education. While deciding the content areas to be programmed, one should not go ahead on ad hoc basis. Priorities should be assigned on the basis of research in areas such as the following :

- vastness of clientele;
- content areas which are generally found difficult by the pupils;
- content areas which are generally found difficult to teach;
- basic conceptual understandings;

- subject areas for which there are no good teachers available.

Perspective planning in production of programmes at the national level could be done with the following points in view:

- programmes on the basic concepts could be produced at national level and regional translations and adaptations may follow (like publications of The Children's Book Trust, New Delhi).
- Foreign programmes may be adapted and translated on the basis of local tryouts.
- Experts could be commissioned to prepare programmes which are in demand.

Decision making for assigning priority should be supported by systematic research at all levels. While discussing the implications for further research, the resources of the developing countries were kept in view. One, however, cannot ignore the fact that researches in programmed learning form a part of the ever-expanding field of learning. Researchers in programmed learning should continue to gain from growing theorizations in the field of learning.

The possibilities of programmed learning material have not been fully revealed. All the same it has proved to be an effective adjunct to other methods of teching. It is for reasearchers to prove that this is not all. We have miles to go before our teachers begin to use programmes in their day-to-day teaching. In the U. S. A., while less than 5% schools used programmed learning in 1961, by the Autumn of 1962, 33% were estimated to be making use of these methods. In India a programme has still remained a rare commodity to be exhibited on occasions. Naik (1969) seems to be correct when he says: What India needs today is a large number of programmes, either prepared or adapted, in different school subjects. The best strategy to sell the idea would be to give the teacher an opportunity to use programmes in the classroom.

In a developing country like India, much could be achieved with the existing resources if an attempt is made to produce programmes with minimum cost and maximum effectiveness. Research in the field would be justified only if it purports to strengthen such an attempt.

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Unreflective salesmanship, uncritical consensus and loud cheering are some of the factors which go against an innovation in the long run. In order to avoid such a mishap, an innovation should be given a fair chance to demonstrate its merits in actual operation. If this is not done, acceptance or rejection of an innovation can prove detrimental. Research workers at the Centre of Advanced Study in Education rightly felt that programmed learning held the promise of being useful to teachers and hence deserved an honest trial in the Indian situation. The Centre had decided to concentrate on some selected areas of research so that something substantial could be contributed in the area. Programmed learning was one such area selected for intensive exploration.

I welcome the publication as it makes a very substantial beginning of systematic efforts to explore the field of programmed learning in the country. I congratulate the research team of the CASE for the job well done.

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